PHILOSOPHY

OF

MINERALOGY.

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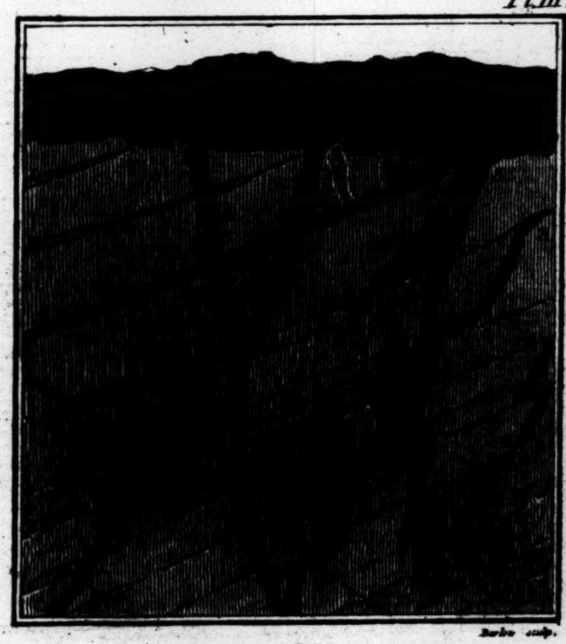
MINERALOGY.

BY ROBERT TOWNSON, L. L. D.

F. R. S. Edinb. etc.—Author of Travels through Hungary.

Pl. III.



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TO

HER GRACE THE

DUCHESS OF DEVONSHIRE.

MADAM,

MEN of ſcience obtain in general that patronage, and their works that attention, from the Public, which they deſerve; yet many inſtances occur, where ſound doctrines have been diſcountenanced from their not coinciding with the opinions of the day, and where their authors have been denied their due recompenſe of fame: hence the progreſs of ſome branches of ſcience has been impeded, and uſe-

ful talents have been checked in their exertions.

I have therefore thought it prudent to put this work, which is ſomewhat new in its kind, under your Grace's protection. Your illuſtrious name muſt enſure it a favourable reception amongſt faſhionable Amateurs, and alſo recommend it to the attention of the Learned.

So far I have been led by ſelf-intereſt in claiming your Grace's protection only for myſelf. But I have another motive in dedicating this work to your Grace, which is more generous; I wiſh to place the ſcience of Mineralogy, which is without a patron, under your Grace's powerful protection, that it may flouriſh in this

country

country like other branches of useful knowledge. For, in tracing the progreſs of the Sciences, we find that ſome of their moſt brilliant epochs have ariſen from the protection of the Great. It is they only who can encourage genius in its inveſtigations, and ſupport, by their influence, ſuch plans as are inſtituted for the advancement of ſcience.

Mineralogy and Geology have in this country been hitherto much neglected.—In none of the public efforts in favour of the increaſe of knowledge have theſe uſeful branches been included; and hence it is that we know ſo little of the mineral productions of our own iſland and the reſt of Europe, and that we are altogether ignorant of thoſe of the other quar-

ters of the globe. Surely, whilſt other branches of Natural Hiſtory receive ſuch liberal protection, Mineralogy ſhould not thus be neglected.

Your Grace will, I truſt, take a pleaſure in promoting the ſcience in which you are ſo eminently ſkilled — and protect, from gratitude, that which muſt have afforded you ſo much rational amuſement. In doing this, your Grace will ſet a noble example of the uſe of wealth and influence, and acquire new claims to the eſteem of the friends of ſcience and uſeful knowledge.

I have the honour to be,

With the moſt profound reſpect,

Madam,

Your Grace's moſt obedient

humble ſervant,

ROBERT TOWNSON.

PREFACE.

THIS little performance is the outline of a larger work which I announced last year at the end of my Travels through Hungary, and which was to have been accompanied by a descriptive Catalogue of Fossils.

The proposal, perfectly disinterested on my part, probably on account of its expence, met with too little encouragement to be executed.—I am therefore

fore free from my engagement; vexed indeed to ſee my favourite ſtudy neglected, and my project not attended to; but rejoiced at being free from the care and trouble which muſt have attended it.

I have by no means altered my opinion of the great utility of the plan I propoſed to the public; but ſtill think, that, had it been properly executed, it would have greatly promoted mineralogical knowledge amongſt us, by facilitating the ſtudy of it, and by fixing the nomenclature and terminology. Many uſeful plans beſides this have failed, from having been offered in unfavourable times, through the want of ſome patron to recommend them, or from their propoſers not being advantageouſly known to the public.

Concerning the present Work, I think it proper to mention, lest I should be censured for treating some of the articles in too light a manner, that it was written in a country town, where I could neither consult collections, books, or men *.—I have only ventured to print a small edition at my own expence; and intend, should it be well received, to improve and reprint it.

The reason of my giving the terminology in Latin and German, as well as in English, may not occur to every one. I therefore assign it. I added the Latin, to assist those who are inclined to describe minerals as well as vegeta-

* I have just been informed that some late analyses have shown that there are no such Earths as the Adamantine and Sydnean Earths, though mentioned by me in the list of Simple Substances.

bles

bles and animals in this language; and gave the German, that it may appear how far my tranſlation is accurate, and to aſſiſt thoſe who read German authors on this ſcience. Where I have differed from the Wernerian School, I have neceſſarily omitted the German.

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OF

MINERALOGY.

CHAPTER I.

Introduction.

MINERALOGY, the subject of our present consideration, concerns the solid part of this globe which we inhabit. The field of enquiry at first sight is immense; but various circumstances bring it within much smaller limits. The greater part of the globe is covered by the immense expanse of water, the seas; and of the remainder, the

vegetable ſoil, gravel, and other looſe materials conceal ſo much, that the rocks appear but in a few places: and as our deepeſt mines are but mere ſcratches, and our higheſt alps but little excreſcences*; when perſevering Science ſhall have extended her reſearches from pole to pole, we muſt ſtill humbly acknowledge, that we are acquainted but with a ſmall part of its ſurface. Thus has Nature here, as every where elſe, oppoſed an inſuperable barrier to human curioſity.

If we take a general view of the ſurface of the earth, we find it diverſified by more or leſs extenſive and deep valleys, by plains,

* This is literally true. The deepeſt mines have not reached the ſix thouſandth part of the diſtance to the centre of the earth; and the Chimboraſſo, in South America, the higheſt mountain in the world, though 3217 French toiſes, is but about the two-thouſandth part of the earth's diameter.

by

by gentle ſwells and hills, and by immenſe ridges and cluſters of mountains; and thus diverſified, without any apparent order, and without any ſeeming reſpect to utility. A further chaos appears upon a nearer examination, and the ſpirit of confuſion ſeems to have preſided at the creation of this part of nature. The ſtrata are broken and miſplaced; the rocks are ſeparated from their beds, and accumulated in heaps; and indubitable marks of the dominion of the ocean and of ſubterranean fires appear in many parts, which from time immemorial have been the natural birthright of the human race.

On a cloſer examination of the materials of our globe, we find them to be very various. Some rocks are ſimple and homogeneous, ſome are compoſed of the broken fragments of others, and ſome are a mere congeries of indeterminate cryſtals. Many bear the marks of having been for a length

of time the ſport of the waters ; others, of having been formed in the boſom of the deep ; and an immenſe quantity of marine organic bodies are found enveloped in ſolid rock, and even conſtituting rocks themſelves.—Not only the productions of the ſea are found at immenſe depths incloſed in ſolid ſtone, but the vegetable productions of the tropics are frequent in our northern climates. One kind of rock covers another, and ſtrata are ſuperincumbent to ſtrata. This announces that our globe, or rather its ſurface, is not the ſimultaneous formation of the omnipotent *fiat*, but the work of ſucceſſive formation and ſubſequent changes.

Theſe ſtrong hints, or rather indubitable proofs, of great revolutions which our globe has undergone, muſt raiſe curioſity in the moſt indolent minds; and philoſophers muſt have loſt their ſpirit of ſpeculation, to behold this ſtate of things without inquiring into

its causes. They have not been indifferent; nor have they been deterred by the difficulty of the inquiry, but rather spurred on to exertion. But observation without discernment forms but a chaos in the mind; and enthusiasm without judgment flies from error to error. It is to science that we must look for instruction. What are the primitive materials of this globe; what the produce of their destruction and decay; what agents have contributed to form, and what to destroy; on what occasions water has been employed, and where fire has acted, are to those who are unacquainted with the general doctrines of mineralogy beyond even conjecture.

The first step in this science is the knowledge of the different elementary substances which belong to the mineral world; the compounds they can form; and the power

and modes of action of the great laws of attraction of aggregation and combination.

However numerous mineral bodies are, their elementary ſubſtances are few; and much fewer thoſe which contribute to form the great maſs of rocks and mountains. For though there are about forty in all, by far the greater part of theſe are but ſeldom found; they are rather curioſities belonging to this part of nature than conſtituents of it, and only about twelve can be conſidered as component parts or materials employed in the fabric of the globe.

Theſe are:

The Calcareous, or Lime,
Barytic,
Magneſian,
Argillaceous and
Siliceous Earths,
Foſſil Alkali,

Carbon,

Carbon,

Muriatic Acid,

Oxygen and

Hydrogen, the components of water: and

Fire.

The other earths, as the zirkon or jargonic, adamantine, auſtral or ſidney, and ſtrontian; with the vegetable and volatile alkalis; the boracic, nitrous, and fluoric acids; and the metals, form foſſils, which, though ſome of them are of great utility to us, but little contribute towards the ſtructure of the earth. However, it is requiſite in a work of this kind that theſe ſhould not be omitted, though I have pointed out the former as objects of particular attention.

Theſe elementary ſubſtances ſhall be the ſubject of the next chapter; for though I ſhould be extremely ſorry that mineralogy

ſhould be conſidered merely as a branch of chemiſtry, and be wholly dependant on it; yet, as it is to chemiſtry we are indebted for the knowledge of the intrinſic qualities of mineral bodies, and through it derive utility from them; and to chemiſtry muſt addreſs ourſelves upon every inquiry concerning their formation, change, or deſtruction; it would ſeem like an obſtinate refuſal, through prejudice, of the moſt friendly aſſiſtance, not to accept its aid.

CHAPTER II.

On the elementary Substances.

CALORIC OR FIRE,

IS only known by its effects. It is invisible, imponderable, subtile, pervading all bodies, insinuating itself between their particles and dilating their masses. It melts solid bodies, rarefies fluids, and renders them invisible. It diminishes the attraction of aggregation, and increases the attraction of composition. It has its affinities.

OXYGEN

We are only acquainted with in a state of gas, where it is combined with caloric. In this state it constitutes about one-fourth of atmospheric air, which, without this, would neither be fit for respiration nor combustion.

Deprived

Deprived of its caloric, it conſtitutes about five-ſixths of water. It is the principle of acidity in the acids, and, combined with the metals, conſtitutes their oxydes or calces.

AZOT,

Though very abundant in nature, acts no grand part in the mineral world: we need therefore ſay but a few words upon it. It is always in a ſtate of gas. Combined with caloric, it forms the azotic gas, which conſtitutes two-thirds of atmoſpheric air. With oxygen it forms the nitrous acid, and with hydrogen volatile alkali.

HYDROGEN

Is likewiſe very abundant in nature, but is of more importance in the organic kingdoms than in this. It exiſts always in a ſtate of gas. It is a conſtituent of water, where it forms about one-ſixth.

SULPHUR

Is well known. It is ſolid, fragile, inodorous and almoſt taſteleſs. It melts with a moderate heat, and is volatile. More ſeldom found in this pure ſtate than combined with the Metals and Earths, where it mineraliſes the former, and with the latter forms hepars. At a certain temperature it unites with oxygen and becomes vitriolic acid, a conſtituent of many common foſſils, and of which we ſhall ſoon ſpeak.

PHOSPHORUS

Is never found uncombined, being ſo combuſtible as to take fire on expoſure to the air in any temperature, and becoming, by the abſorption of more than its own weight of oxygen, phoſphoric acid.

CARBON

In its pure ſtate is the principal conſtituent of foſſil coal, and the ſole conſtituent of charred

charred wood, and is found in all vegetable and animal bodies. At a high temperature it has the ſtrongeſt affinity for oxygen, and combined with it forms carbonic acid, an aëriform fluid, of which we ſhall preſently ſpeak.

THE METALS,

Which are ſeventeen in number, excluſive of the uranite and menachanite, poſſeſs theſe properties in common: Great weight, fuſibility, and, without previous oxydation, inſolubility in acids; which may diſtinguiſh them from the preceding bodies. They differ, however, much from one another, ſome being brittle, and combine with ſo much oxygen as to become acids; as arſenic, tungſten, and molybden:——others are brittle, and become only oxyds; as cobalt, biſmuth, nickel, manganeſe, and antimony:—others again are demiductile and oxydable, as zink and mercury:—again others are very ductile

and

and oxydable; as tin, lead, iron, and copper: —and lastly, there are those which are very ductile and difficultly oxydable; as silver, gold, and platina. Few of them are found in the pure or metallic state; they are more generally oxygenated, or combined with sulphur, arsenic, vitriolic acid, &c. &c. They never form great rocks and strata, but are found in veins, filling up the chinks and crevices in them, and likewise in thin beds between the strata.

Arsenic is very volatile and oxydable, and, heated in open vessels, evaporates in a white smoke, and with a strong garlic smell. It is not affected by vitriolic acid unless hot, but readily by the nitrous. It is often combined with the other metals.

Spec. gr. 8,308.

Tungsten is almost infusible, and is insoluble in the strong mineral acids, but readily oxydable. It is never found pure, that is

in

in the metallic ſtate, but is combined in the ſtate of acid with lime, forming tungſten, and in the ſame ſtate with iron and manganeſe, forming wolfram.

Molybden is almoſt infuſible, but very oxydable and acidifiable. It is never found in a metallic ſtate, and can ſcarce be brought into it by the aid of chemiſtry. It is commonly found combined with ſulphur.

Spec. gr. 7,500.

Cobalt is of difficult fuſion, but very oxydable, though not acidifiable. It is never found in a metallic ſtate, but often in that of oxyde, and frequently combined with arſenic, iron, and ſulphur.

Spec. gr. 7,811.

Biſmuth is very fuſible, and very oxydable. It is found in its metallic ſtate.

Spec. gr. 9,800. Fuſible at 460 of Fahr.

Nickel is of very difficult fuſion. It is never found in its metallic ſtate, and is generally

intimately

intimately combined with iron, cobalt, arsenic, and ſulphur.

Spec. gr. 7,807 Briſſon, 9,000 Bergman, (when pure.)

Manganeſe is except platina of the moſt difficult fuſion, and ſo very oxydable, that it turns to a black oxyde on mere expoſure to the air. It is never found in a metallic ſtate, and can ſcarce be reduced to this by the aid of chemiſtry.

Spec. gr. 6,850.

Antimony melts in a red heat, and is then oxydable, and in ſome degree acidifiable. It is ſeldom found in a metallic ſtate; it is generally combined with ſulphur.

Spec. gr. 6,702 to 6,860. Fuſib. 780 Fahr.

Zink is demiductile and fuſible in a red heat, and the moſt inflammable of the metals, burning at this temperature with a white flame. It is ſeldom or never found in its metallic ſtate, but frequently in a ſtate of oxyde,

oxyde, and is then called calamine, and is often combined with ſulphur.

Spec. gr. 6,800 to 7,190. Fuſib. 741 Fahr.

Mercury is ſo very fuſible, that it is always fluid, even in the coldeſt weather of our climates, and requires the ſevere froſts of Siberia to be in a ſolid ſtate. It freezes only at 31 degrees under 0 of Reaumur; it oxygenates by degrees on expoſure to the air. It is found in its metallic ſtate, but more frequently combined with ſulphur, when it is called cinnabar.

Spec. gr. 13,568 to 14,000.

Tin is the moſt fuſible of the metals, mercury excepted, and the lighteſt, and very oxydable with heat. Seldom or never found in a metallic ſtate.

Spec. gr. 7,290. Tenac. 49*. Fuſib. 410, of Fahrenheit.

* That is, a thin rod or wire of $\frac{1}{10}$th of an inch in diameter will bear a weight of 49 pounds.

Lead

Lead is the ſofteſt and leaſt tenacious metal, heavy, and very fuſible and oxydable. It is ſeldom or never found in its metallic ſtate, but very frequently combined with ſulphur.

Spec. gr. 11,325 to 11,552. Tenac. $29\frac{1}{2}$.
Fuſib. 540 of Fahr.

Iron is of very difficult fuſion, very hard, the moſt tenacious, one of the lighteſt after tin, very oxydable, and, excluſive of every other body in nature, magnetic. It is found in the three kingdoms of nature; is very abundant in the mineral, but ſeldom or never found in its metallic ſtate; moſt frequently in a ſtate of oxyde, or with ſulphur, or in a ſtate of vitriol.

Spec. gr. about 7,500. Tenac. 450.
Fuſib. 17,977 of Fahr.

Copper is diſtinguiſhable from all the preceding metals, by its colour, taſte, and ſmell. It is very malleable, of rather difficult fuſion, and very oxydable. This metal, which

is likewiſe very abundant, is frequently found in its metallic ſtate, and likewiſe combined with ſulphur, and in a ſtate of oxyde.

Spec. gr. about 8,800. Tenac. 300. Fuſib. 27 of Wedg. at 4,587 of Fahr.

Silver is very malleable, rather infuſible, ſcarcely oxydable by heat and expoſure. It is found in its metallic ſtate, likewiſe combined with ſulphur, &c.

Spec. gr. 10,000 to 11,000. Tenac. 270. Fuſib. at 4,717 of Fahr.

Gold is the heavieſt metal except platina, and the moſt malleable, and very tenacious. It requires a white heat to melt it; is leſs oxydable than ſilver. It is commonly found in its metallic ſtate, but is often mixed in other metals.

Spec. gr. 19,250 to 19,640. Tenac. 500. Fuſib. 5,237 of Fahr.

Platina is the heavieſt, the hardeſt, the moſt infu-

infuſible, and the leaſt oxydable of the metals; a ſcarce foſſil, and only found in its metallic ſtate.

Spec. gr. from 21 to 24.——Of the *Uranite* and *Menachanite*, which are newly diſcovered metals, very little is known.

We ſhall now proceed to the Earths. And ſome of them, being the principal materials in the compoſition of our globe, merit particular attention. They poſſeſs in common the characters of being white, taſteleſs, inodorous, dry, almoſt inſoluble (in water), infuſible, uninflammable, fixed and undecompoſable bodies. In their moſt ſimple ſtate, in the ſtate of an impalpable powder, they can have only chemical characters.

SILEX,

Excluſive of the characters juſt mentioned, is inſoluble and uncombinable with all acids ex-

cept the fluoric. It is fusible with a great heat with the alkalis, and some of the alkaline earths. Silex is very abundant in this kingdom of nature; and as it scarce combines with any acid, it is frequently found pure. It is the sole constituent of quartz, and a principal one of all the siliceous fossils, as silex, petrosilex, jasper, sandstone, &c. &c. and of many others which are classed amongst the argillaceous and magnesian fossils.

ARGILL

Is best known by its forming alum with the vitriolic acid, and combining with most acids. It enters into the composition of most fossils, is the principal constituent of a few, but the sole constituent of none. According to Mr. Lavoisier, it is the only earth which is fusible through the means of vital air.

BARYTE

Is remarkable by its weight and strong affinity

nity for vitriolic acid, and by having in general a greater affinity for moſt acids than the alkalis themſelves. It is leſs inſoluble than the other earths, is never found pure, but often combined with the vitriolic and carbonic acids, and enters into the compoſition of ſome other foſſils, though it is the leaſt abundant of the five common earths.

MAGNESIA,

In the pureſt ſtate we have it, but in which it is not found in nature, is as remarkably light as the preceding is heavy. It forms with acids very ſoluble compounds, and ſome that are deliqueſcent and moſtly bitter; but with the vitriolic, the Epſom or bitter ſalt, which is not deliqueſcent. Though never found pure, or even forming the predominant portion of any mineral body, it is a conſtituent of many; as the lapis ollaris, ſteatites, ſerpentines, talcs, &c. &c.

CALX OR LIME,

Is the moſt alkaline and cauſtic of the earths, and from its great tendency to unite with water, the carbonic and other acids, is never or ſeldom found pure in nature. It is likewiſe the firſt amongſt the earths and alkalis in its affinity for the fluoric and boracic acids. It is extremely abundant in nature, conſtituting, with the carbonic acid, limeſtone, which in many parts of the earth forms immenſe chains of mountains, likewiſe marble, chalk, &c. With vitriolic acid it forms gypſum, which is found in immenſe beds in many parts, and with the fluoric acid it forms fluors. It is ſometimes likewiſe found combined with the phoſphoric and tungſten acids.

The following four Earths are rarely found; and being rather curioſities in, than conſtituents of, the mineral world, particularly the three latter, I ſhall only juſt enumerate them,

STRONTIAN EARTH

Is never found pure. It is more ſoluble than lime, and heavier, and has greater affinity for the ſtrong mineral acids; but it is lighter than baryte, and has leſs affinity for theſe acids. Hitherto only found combined with carbonic acid.

JARGON EARTH.

Its properties are not well known. It is only a conſtituent of a precious ſtone found in Ceylon.

SIDNEY EARTH

Is fuſible, and only ſoluble in the marine acid. Found lately at Sidney Cove, in New South Wales, as a component of ſand.

ADAMANT EARTH,

Its properties are not well known. It differs from the ſiliceous by being infuſible by

alkalis, and from the other earths by its insolubility in acids.

The Fixed Alkalis are known by their acrid taſte, and ſolubility in water, from the Earths, with which they have many properties in common.

VEGETABLE ALKALI

Has ſo ſtrong an affinity for water and the acids, that it is never found pure. It is of little importance in the mineral kingdom. It is the baſe of ſaltpetre, and is produced by the incineration of vegetables.

MINERAL ALKALI

Is very ſimilar to the preceding, but ſhews its diſſimilitude in its combinations with the acids. It exiſts in much greater abundance, being the baſe of common ſalt, and is often found on the ſurface of the earth com-

bined with carbonic acid, and may be extracted from marine plants.—Of the VOLATILE ALKALI I ſhall ſay nothing, as it is now known to be not a ſimple, but a compound body, and hardly belongs to this kingdom of nature; but is very abundant in the animal, and is likewiſe found in the vegetable. It is ſaid to be found in ſome combinations about the mouths of volcanos.

VITRIOLIC OR SULPHURIC ACID,

As I have before remarked, is compoſed of ſulphur and oxygen, in the proportion of about 2 of ſulphur, and 1 of oxygen. It is an inodorous fluid, but very cauſtic, twice as heavy as water, but leſs volatile. It has the ſtrongeſt affinities for the ſimple earths (ſilice excepted) and the alkalis; forming, for inſtance, with baryte baroſelenite, with lime or calcareous earth ſelenite, and alum with

argill. It unites with the metallic oxydes, forming the vitriols of zink, iron, &c. &c.

CARBONIC ACID

Is aëriform in the coldeſt temperature. It is compoſed of 28 parts of carbon, and 72 of oxygen. It is heavier than atmoſpheric air, of which it either forms a very ſmall part, or with which it is frequently mixed. It is very abundant in the mineral kingdom, being a conſtituent of limeſtones, chalk, and ſome other foſſils and acidulous waters, and, though the weakeſt of mineral acids, is one of the moſt important in this kingdom of nature.

NITROUS ACID

Is a cauſtic fœtid fluid, formed of azot and oxygen, of great moment to the chemiſt, but of little to the mineralogiſt, being a component of very few foſſils.

MURIATIC

MURIATIC ACID

Is a cauſtic fœtid fluid of unknown elements, not having been hitherto decompoſed; of conſiderable importance in mineralogy, being a conſtituent of rock ſalt.

FLUORIC ACID

Is aëriform, and has likewiſe not yet been decompoſed. It is peculiar in being the only ſolvent of ſilex. It is only found combined with calcareous earth, with which, unlike the preceding acids, it has the firſt or ſtrongeſt affinity in preference to the alkalis, forming with it the Fluors.——Of the

BORACIC ACID,

Which is concrete, and not decompoſable, and rarely found either free or combined; and of the

PHOSPHORIC ACID,

Which is formed by the combination of phoſphorus

phoſphorus and oxygen, and is never found free, and ſeldom combined with any foſſil body, I need ſay no more, and merely enumerate the three metallic acids. The

ARSENIC ACID,

Which is concrete, and formed of arſenic and oxygen. The

TUNGSTENIC ACID,

Likewiſe concrete, formed of tungſten and oxygen. And the

MOLYBDIC ACID,

Likewiſe concrete, and formed of molybden and oxygen.

WATER,

Though not a ſimple elementary ſubſtance, being a compoſition of 85 parts of oxygen and 15 of hydrogen, is ſo univerſally extended through the mineral world that I muſt not omit it. In its moſt

ſimple

ſimple ſtate it is hard and ſolid, brittle and tranſparent, and is called ice; and is thus found in immenſe rocks, in the cold regions of the north and ſouth, and during the winters of our milder climates; but it becomes fluid, and aſſumes the name of water at 0 of Reaumur and 32 of Fahrenheit, by the addition of caloric. In this ſtate, by its affinity to moſt bodies, it is the grand ſolvent of nature, not only diſſolving all ſaline bodies, but affecting in a ſmall degree moſt foſſils. It is found in every mineral body, even in the hardeſt, and in ſaline cryſtallizations in great quantities, as in alum, where it conſtitutes one half, and in the carbonate of ſoda or natron two thirds, of the body. In this ſtate it is called the water of cryſtallization: but on becoming a conſtituent of ſuch concrete bodies, it lets go its caloric, and in ſome caſes in greater quantity than

would

would merely reduce it to a ſtate of ice. At 80 degrees of Reaumur it becomes aëriform, and expands to an immenſe volume.

Such are the materials of our globe; and it will be ſeen, though I have kept ſtrictly to the components of the mineral kingdom, that I have enumerated all the ſimple ſubſtances in nature; for it ſeems that both vegetables and animals, notwithſtanding their almoſt infinite variety, are compoſed of hydrogen, carbon, oxygen and azot, all of which are found in this kingdom of nature, and all but the laſt in abundance.—I have done little more than enumerate them. To have given a fuller account, I muſt have written a ſyſtem of chemiſtry; yet this ſhort ſtatement ſhows how much they differ in their properties. This ariſes from their different affinities or tendencies to reciprocal combination,

nation, which exiſts throughout the mineral world, and which is the conſequence of ſome great laws, by which this inorganic part of nature is governed. Theſe laws ſhall be the ſubject of the next chapter.

CHAP-

CHAPTER III.

On the Laws of Attraction of Aggregation and Combination.

THE more we examine the vegetable and animal worlds, the more we obſerve of deſign and contrivance. The moſt ſpendid works firſt ſolicit and gain our attention, for men, like children, have thus their curioſity excited. But this ſpirit being once raiſed, we then find in the ſimpleſt productions ſubjects of admiration, and can then ſit unwearied contemplating the beauties and wonderful œconomy of a humble moſs or lichen. Plan and deſign are in all Nature's works, though univerſal diſcord and confuſion ſeem to prevail, and though certain ruin awaits her faireſt productions. A plant or animal comes into exiſtence feeble; but

with

with inherent powers adequate to the difficulties to be oppoſed, and to the offices it has to perform. It increaſes, acts its part in the œconomy of nature; continues its ſpecies, and dies. Each creative is balanced by a deſtroying power, and each deſtroying counteracted by a creative; and thus the organic world, after the lapſe of ſo many ages, ſtill continues the ſame, though the individuals which compoſe it are ever changing. Were things at reſt, there would be no need of any powers in nature; and conſequently there would be no laws by which to be directed. But things are far otherwiſe. The modes of acting of theſe powers, which are ever the ſame, are the laws; and theſe are only known by their effects.

Bodies ſo different as the inorganic and organic cannot be ſuſpected of being governed by the ſame laws. In the latter, it is the mechaniſm of the ſtructure which per-

forms every thing, directing the matter. In the former, it is the matter itself which possesses the power. If we examine what passes in organic bodies, as well vegetable as animal, we find the various individuals endowed with a structure by which they take in different substances foreign to their own; separate, and assimilate to themselves what is proper, and reject what is useless or hurtful; and this from their first feeble rudiment. Thus the small acorn becomes a lofty oak, and the inert egg an active sensitive animal. We observe the gradual change taking place, the increasing stature and development: we see in part the mechanism by which it is accomplished, but know not its moving principle nor mode of acting. We candidly acknowledge our ignorance, and without meaning to explain it, attribute it to an organic structure, and call it a growth of intus-susception.

The matter taken in is considered as inert, and power and action are attributed to the organic body alone. Could we see further, probably, we should find that the chief use of this structure is to bring the extraneous matter within the sphere of reciprocal action; we should see that this structure performed the office of the instruments of the chymist's laboratory, by which bodies through comminution, trituration, &c. &c. are adapted to act upon each other.

The elementary substances of the mineral kingdom are not inert; they have their active powers, and these we will now proceed to examine. Two laws govern the mineral world: attraction of aggregation, and attraction of combination. To the first, mineral bodies owe their existence in separate homogeneous masses, in opposition to the state of accidental and heterogeneous mixture. They likewise owe to it their re-

gular cryſtalline forms; and without this law, the ſolid parts of our globe would only have been a confuſed chaotic maſs. To the latter we are indebted for the great variety of compound bodies which are the reſult of ſo few elementary ſubſtances, and likewiſe for the changes that take place amongſt them; even the proceſſes performed in the laboratory of the chymiſt are founded on this. Laws ſo important require a deeper examination: let us therefore conſider them more in detail. And firſt of AGGREGATE ATTRACTION.

Bodies that are ſolid have their active powers centred in themſelves, and eternal repoſe is the reſult; unleſs another body, in conſequence of the attraction of combination, unites with them, when a new body is formed. But all bodies in a fluid ſtate are combined with their ſolvent, and then their particles, thus ſeparated, have little tendency to unite with each other. But as ſoon

as

as this ſolvent is withdrawn, the particles that compoſed the ſimple ſolid body again unite: and they unite according to particular laws; ſo that, as we ſhall afterwards ſee, under proper circumſtances they form regular polyedral figures invariably the ſame. If ſeveral are mixt in the ſame ſolvent, they in becoming ſolid do not unite indifferently, and without ſelection, and thus form a heterogeneous mixture; though this would certainly be the caſe, did the great law of attraction, by which great maſſes are governed, prevail, where attraction is in the reverſe ratio of the ſquares of their diſtances; but each unites excluſively with its own kind: and the conſequence of this is, that, inſtead of a tumultuous chaotic mixture, we have beautiful cryſtals, each kind having its own proper character.

Mr. Pelletier, an ingenious French chymiſt, relates the following curious experiment, which

which admirably exemplifies this doctrine. He mixed a solution of alum in a semifluid mass of clay, and, having stirred them well together, left it till it was dry: he then broke it, and found the alum had formed regular crystals. It is quite evident, that, instead of regular crystals, if nothing but the common law of attraction had acted, the alum would, though concrete, have been still dispersed through the mass of clay; and as in this semifluid mass there could have been no cavities, it is equally plain that the particles of alum had the power to throw aside the particles of clay, and unite with their similar particles. To this law, then, the law of aggregate attraction, we are indebted for every thing that is homogeneous and symmetric in the fossil kingdom. The different kinds of elementary matter, of which fossils are composed, then, are not inert, but possess active specific powers, by which they form

form homogeneous and regular figures; and the form of cryſtals is the natural ſtate of the bodies belonging to this kingdom of Nature, notwithſtanding ſo very ſmall a part of its productions is found in this ſtate.

To the formation of regular cryſtals, it is requiſite that the matter be ſufficiently attenuated through heat, or through the ſolving menſtruum, and that the buſineſs of aggregation ſhould proceed in a ſlow and tranquil manner. But though a very ſmall part of our earth is compoſed of *regular* cryſtalline bodies, this law of aggregate attraction has preſided at the formation of a great part of it: for all bodies that have a ſparry or ſpathous texture are nothing but a more or leſs tumultuous aſſemblage of indeterminate and half-formed cryſtals. Let us examine ſtill more in detail this ſubject of cryſtallization.

There is this analogy between the organic

nic and inorganic bodies, that in their increaſe or growth they retain their firſt forms, and their change or difference is only in ſize: the former acquire this, by an intus-ſuſceptive growth; the latter, by a juxta-poſition of particles. As far as our ſight, even aided by the microſcope, will extend, we ſee that the firſt rudiment of a cryſtal is its perfect form; that in this its embryo ſtate, if we may uſe the expreſſion, it differs only in ſize from what it will be hereafter. But we know by experience, that ſeveral circumſtances are requiſite to the formation of regular cryſtals. It is probable, that the primary particles of which they are compoſed are polyedral forms; and that towards the formation of regular cryſtals they muſt unite, not accidentally but by particular ſides; yet it muſt be admitted, that as the primary particles are infinitely ſmall, a greater accumulation on any particular

ticular ſide may be one cauſe of irregularity, though the juxta-poſition ſhould take place by the ſame ſides. Many *luſus naturæ* in the cabinets of the curious in cryſtallizations ſhew this.

It will, I think, now be eaſy to conceive, that many minerals which have not regular forms may be the reſult of cryſtallization; and that we may go by degrees from the moſt perfect geometric figure to the moſt tumultuous aſſemblage of cryſtalline particles. In the ſenſe in which the word cryſtallization is here uſed, every concretion from a fluid ſtate is the reſult of cryſtallization, and may exiſt either in the ſtate of regular cryſtals, or be ſo irregular as not to be definable, or in the ſtate of confuſed aggregated particles. Theſe three different ſtates, it is not neceſſary to obſerve, run into one another. It is in this latter ſtate that many of the minerals that form entire mountains

mountains are found; probably all, except thoſe which are formed of the powder, duſt, or fragments of other rocks, as the breccias, ſand-ſtones, &c.: yet even theſe are but the ruins of thoſe which had been formed in this manner. It is, then, to this law we owe every thing that is cryſtalline, ſymmetric, and homogeneous.

However important the law we have juſt treated of may be in the formation of foſſils, it muſt be clear, upon an attentive conſideration of its characters, that it can only be the cauſe of the aggregation and concretion of the elementary ſubſtances; that though it brought theſe out of their chaotic confuſion into beautiful homogeneous maſſes, and regular ſymmetry; yet it never could combine them, and in various proportions; and thus create, from ſo few elementary principles, ſuch a multiplicity of minerals as are the reſult of theſe combinations.

nations. This is dependent on a quite different law, in ſome degree an oppoſing one, the LAW OF ATTRACTION OF COMBINATION, which we will next conſider.

What are the real elementary and ſimple ſubſtances; whether any of thoſe which we conſider as ſuch are really ſo, muſt be anſwered with a modeſt doubt. We are right to conſider thoſe as ſuch, which hitherto have admitted of no further analyſis, and which by ſyntheſis we cannot form; but as chymiſtry throughout its progreſs has from time to time, by the analyſis of theſe ſuppoſed elements, ſhewn us our error, we ought to hold this opinion with the diffidence of uncertainty, or perhaps rather receive it merely as a convenient language or mode of expreſſion.

We did not enquire into the cauſe of the preceding law, we were content with obſerving its effects; nor ſhall we attempt

now

now to find out the caufe why certain bodies combine together in preference to others, but merely ftate the facts, and then fhew the immenfe importance of this law. As the fcience of chymiftry is little more than the knowledge of the preferring or felecting difpofition of the different elementary fubftances and their compounds, and its operations little more than the adjufting and difpofing them to reciprocal action, every page of chymiftry muft bear witnefs to the exiftence of this law. It has this conformity with the laft kind of attraction, and this difference with the attraction of great maffes, that it only acts when the bodies are almoft or altogether in contact.

Though this law merely concerns matter of different kinds, there is no univerfal rule that there fhould be a combination between *any* two of them indifferently; for, on the contrary, there are fome that never will

combine

combine together. When this union takes place, a new ſubſtance is formed, with properties different from the components, and which could never be aſcertained by any reaſoning *à priori.* There is an intimate union of the different principles, and the volume is in general diminiſhed, and the temperature changed. Yet are they not ſo combined or altered, but that often thoſe bodies which had a ſtronger affinity with either before this combination took place will ſtill act upon them, and that in proportion to the ſtrength of the affinity of the united principles. In moſt caſes where a third ſubſtance preſents itſelf, no further combination takes place, except where it has a ſtronger affinity for one of them. Then a decompoſition takes place, and a new ſubſtance is formed: but in ſome caſes this third ſubſtance unites with the compound, which changes accordingly its properties.

Though

Though ſuch triple combinations are but little within the power of the chymiſt's art, yet are they very common in Nature: here the elementary bodies are often found united not only 3, but 4 or 5 together. Thus, for inſtance, the Emerald, according to the analyſis of Mr. Bergman, is the combination 22 parts of ſilex, 60 of argill, 8 of lime, and 6 of iron. The Hyacinth, according to the ſame celebrated chymiſt, is compoſed of 25 parts of ſilex, 40 of argill, 20 of carbonated lime (or about 6 of carbonic acid, and 14 of lime), and 13 of iron: here is a combination of five ſimple ſubſtances excluſive of water, and both the carbonic acid and water are compounds. The Labrador Feldſpar is, according to Mr. Bindheim, compoſed of 69 parts of ſilex, 13 of argill, 12 of gypſum (a compoſition of about 7 parts of vitriolic acid and 5 of lime), 7 of oxyde of copper, and 0,036 of oxyde

of

of iron (both compounds). The Prehnite, according to the celebrated Mr. Klaproth, is a combination of 44 parts of ſilex, 30 of argill, 18 of lime, 5 of iron, and 2 of water and air. Theſe are examples enough to ſhew that nature uſes the elementary ſubſtances to form new bodies; and ſo far are ſuch combinations from being ſcarce occurrences in the mineral kingdom, that there are very few foſſils which are not combinations of ſeveral ſimple ſubſtances.

A great difficulty here ariſes relative to mixture and combination, which though perfectly different in their natures are ſometimes not to be diſtinguiſhed. There can be no doubt, but that the principal components of hard pellucid cryſtalline bodies are in a ſtate of combination; but likewiſe there can be no doubt, that often adventitious matter is enveloped in their maſſes, with which they are only mixt. For we know by

experience,

experience, notwithstanding what I have stated relative to aggregate attraction, that in many cases circumstances are such, that the crystalline matter is not able to reject the heterogeneous, but envelops it in its substance. This is often observed in rock crystal, in which chlorite earth, actinolite, asbestus, &c. are found; and sometimes the former are so intimately mixt with it, and in such quantities, that the fossilist is inclined to refer it to a different genus. In the crystallised sand-stone of Fontainebleau, though the calcareous spar is mixt with twice its own quantity of sand, yet it assumes its usual crystalline form.

If it be then difficult in regular crystalline bodies to know which of their components is combined, and which only mixt; how much greater must the difficulty be to ascertain this in the great rocks, the result of confused crystallization! In these, it is clear, if

if we reflect on what muſt have paſſed on their concretion, that nothing heterogeneous could have been rejected and thrown aſide as in the formation of regular cryſtals, but that every thing mixt in the fluid maſs muſt have been inveloped, and muſt now conſtitute a part. A means of aſcertaining this, I dare ſay, will occur to ſome philoſophers; and probably it may be this: that thoſe components which are only mixt and not combined may be readily extracted by certain reactives, which will not affect them if they are in a ſtate of combination. This, I am afraid, though true in theory will be difficultly put in practice.

Some of my ſpeculative readers will probably aſk how theſe elementary ſubſtances can have been combined, and how they have cryſtallized, ſince neither the components nor the compounds are ſoluble in water. This queſtion, I believe, has never been an-

ſwered; and it has given riſe to, or ſupported the opinion, that fire has been the agent in theſe proceſſes. Yet difficulties, at leaſt equally great, I think, will be found in this hypotheſis, which it would be improper for me, on account of the extent of the neceſſary diſcuſſion, to ſtate. The opinion that I have formed on this ſubject, to relate in a few words, is this: That there can be no doubt that there was a time when the preſent great maſſes and beds of rock were not in exiſtence, when the elementary ſubſtances of which they are compoſed were free, that is, uncombined; that theſe elementary ſubſtances were more ſimple than what we conſider ſuch at this day; which moſt chymiſts, though they have no hypotheſis to ſupport, are inclined to think are formed of ſtill more ſimple elements. If this be granted, it may then be eaſily conceived that they were in a ſtate of ſolution in water, notwith-

notwithstanding *our present elementary substances, the result of their combination*, are insoluble in this fluid; just in the same manner as the very soluble bodies, the tartarous acid, and the vegetable alkali, form by their union an almost insoluble compound. It should always be recollected, that there is now no process going on in nature similar to that by which our rocks and strata were formed.

Before I conclude this chapter, I will just remark, that all these compounds are to be considered as perfect distinct and homogeneous substances, each an *ens sui generis*, and that they obey the laws of aggregate attraction, as though they were simple bodies. Having explained these two universal laws, I will in the next Chapter enumerate the different mineral bodies, as well the simple as those which are the result of their combination.

CHAPTER IV.

Of the different Kinds of Minerals, or Mineral Combinations.

IN undertaking to give an account of fossils in the manner I mentioned in the preceding chapter, I know I undertake a very difficult task; neither is mineralogy so far advanced, nor the analysis of mineral bodies in any degree so complete, as that any thing like an accurate systematic arrangement can at present be expected on these principles. In regard to our deficiency in mineralogical knowledge, it is well known that chymists have been too negligent in describing the subjects of their analysis, so that we are often ignorant of the real object of their researches. And in regard to the analyses themselves, they are too few in number, some fossils having never yet been carefully examined:

examined: nor are many of our analyſes from ſuch ſkilful hands, that in a thing ſo intricate, ſo liable to error, we can place implicit confidence; but here, as in other concerns, we muſt make uſe of the light that is offered to us, rather than remain ſullenly inactive and repine at the deficiency. And I beg it will be recollected, that I am not writing a ſyſtematic deſcription of minerals, but only treating of the general doctrines.

SALTS.

Carbonate of Soda *	Carbonic acid 16. Alkali 20. Water 64.
Borate of Soda	Boracic acid 34. Alkali 17. Water 47.
Muriate of Soda	Muriatic acid 52. Alkali 42. Water 6.
Muriate of Ammoniac	Muriatic acid 52. Alkali 40. Water 8.
Nitrate of Ammoniac	Nitrous acid 46. Alkali 40. Water 14.
Sulphate of Ammoniac	Sulph. acid 42. Alkali 40. Water 18.

* Here I have uſed the "Syſtematic Arrangement of Minerals by W. Babington," with trifling alterations.

EARTHS.

Lime ?	
Carbonate of Lime	Carbonic acid 34. Lime 55. Water 11. The analyses vary.
Swine-ſtone	Carbonated lime impregnated by petroleum.
Sidero-calcite	Carbonated lime 60. Oxyde of manganeſe 35. Iron 5.
Baryto-calcite	Carbonated lime 92. Carbonated Baryte 8.
Muri-calcite	Carbonated lime 52. Carbonated magneſia 45. Iron and manganeſe 3.
Argentine	Carbonated lime, magneſia, argill and iron.
Dolomite	Lime 44,29. Carbon. acid 46,1. Argill 5,80. Magneſia 1,4. Iron 0,074.
Fluate of Lime, or Fluor	Fluor acid 16. Lime 57. Water 27.
Phoſphate of Lime	Phoſphor. acid 45. Lime 55.
Sulp. of Lime or Gypſum	Sulphur. acid 46. Lime 32. Water 22.
Carbonate of Strontian	Acid 26,5. Strontian 73,5.
Carbonate of Baryte	Acid 20,8. Baryte 78,6.
Sulphate of Baryte	Sulph. acid 32,8. Baryte 67,2.
Bolonian Stone	Sulphate of baryte 62. Silex 16. Argill 15. Sulphate of lime 6. Water 2.
Liver Stone	Sulphate of baryte 38. Silex 33. Sulph. of argill 22. Sulphate of lime 7. Petroleum 5.
Calci-murite	Magneſia, lime, and ſome iron.

Argillo-

Argillo-murite	Magnesia 13. Silex 50. Argill 10. Lime 3. Oxyde of iron 0,9. Water 12.
Silici-murite	Silex 50, with carbonate of magnesia, and iron.
Meerschaum	Magnesia 50. Silex 50.
Talc	Magnesia 44. Silex 50. Argill 6.
Lapis Ollaris	Magnesia 38. Silex 38. Argill 7. Iron 5.
Steatites.	
Serpentine	Magnesia 33. Silex 45. Magnetic Iron 14. Carbonate of lime 6,25. Argill 0,25.
Chlorite	Magnesia 39. Silex 41. Argill 6. Lime 1. Iron 10.
Asbestos	Carbonated magnesia 16. Silex 63. Carbonated lime 12. Argill 1. Oxyde of iron 6.
Amianthus	Carbonated magnesia 18,6. Silex 64. Carbon. lime 6,9. Baroselenite 6. Argill 3,3. Oxyde of iron 1,2.
Suber Montanum and the Actynolite differ so little in the Analysis, that they can form but one Genus.	Carbonated magnesia 22. Silex 62. Argill 2,8. Carbon. of lime 10. Oxyde of iron 3,2.
Jade	Carbon. of mag. 38. Silex 47. Carbon. of lime 2. Argill 4. Oxyde of iron 9.
Baikalite	Magnesia 30. Silex 44. Lime 20. Oxyde of iron 6.
Boracite	Boracic acid 68. Magnesia 13. Lime 11. Silex 1. Argill 1. Iron 1.
Carbonate of Argill?	Carbonic acid, argill and some lime.

Clay

Clay *	Carbonated argill and filex.
Lithomarga	Argill 11. Silex 60. Carbon. lime 5,7. Carbon. magnesia 0,5. Oxyde of iron 4,7. Air and Water 18.
Fullers Earth	Argill 0,25. Silex 0,51. Carbon. lime 0,03. Carbon. of magnesia 0,007. Oxyde of iron 003. Water and Air 0,15.
Bole	Argill 19. Silex 47. Carbon. lime 5,4. Carbon. magnesia 6. Oxyde of iron 5,4. Water and Air 17.
Tripoli	Argill 7. Silex 90. Iron 3.
Lepidolite	Argill 38,25. Silex 54,5. Oxyde of iron and Manganese, 0,075. Water and Air 2,7.
Sappare	Argill 67. Silex 13. Magnesia 13. Iron 5. Lime 2.
Mica	Argill 28. Silex 38. Magnesia 20. Oxyde of iron 20.
Micarelle	Argill 63. Silex 29. Oxyde of iron 7.
Hornblende (basaltic)	Argill 27. Silex 58. Lime 4. Magnesia 1. Iron 9.
Ditto (schistose)	Argill 22. Silex 37. Magnesia 16. Lime 2. Iron 23.
Ditto (resplendent)	Argill 17. Silex 43. Magnesia 11. Iron 23.
Basalt	Argill 15. Silex 50. Carbon. lime 8. Iron 25. Magnesia 2.

* The components of this, and a few more in this catalogue, which are in an earthy state are probably only mixed, not combined.

Trap

Trap	Argill 32. Silex 47. Oxyde of iron 20.
Calp	Argill, silex and iron, with 50 per cent. carbonated lime.
Argillaceous Schistus	Argill 25. Silex 60. Magnesia 9. Iron 6, and some Petroleum.
Diamond ?	
Sapphire	Silex 35. Argill 58. Carbonated lime 5. Iron 2.
Topas of Brazil	Silex 52. Argill 44. Lime 2. Iron 0,03.
Beryl of Siberia	
Ruby	Silex 16. Argill 76. Lime 1. Iron 3.
Emerald	Silex 24. Argill 60. Lime 8. Iron 6.
Aqua Marine	Silex 64. Argill 24. Lime 8. Iron 1.
Chrysolite	Silex 15. Argill 64. Lime 17. Iron 1.
Hyacinth	Silex 25. Argill 40. Carbon. Lime 20. Iron 13.
Vesuvian Hyacinth	
Olivin	Silex 54. Argill 40. Iron 4.
Garnet	Silex 48. Argill 30. Lime 11. Iron 1.
Vesuvian Garnet (Leucit)	Silex 55. Argill 39. Lime 6.
Tourmalin	Silex 37. Argill 39. Lime 15. Iron 9.
Schorl	Silex 52. Argill 37. Lime 5. Magnesia 3. Iron 3.
Thumerstein	Silex 52. Argill 25. Lime 9. Iron 9, and some Manganese.
Schorlite	Silex 50. Argill 50.
Rubellite	Silex 57. Argill 35. Oxyde of iron and Manganese 5.

Amethyst

Amethyst	Silex 30. Argill 60. Lime 8,22. Iron 1,66.
Quartz	Silex 93. Argill 6. Lime 1.
Prase	
Elastic Quartz	Silex 0,965. Argill 0,025. Iron 0,01.
Obsidian	Silex 69. Argill 22. Iron 0,09.
Calcedony, including Cornelian, Agates, &c.	Silex 84. Argill 16.
Chrysoprase	Silex 0,96. Oxyde of nickel 0,01. Lime 0,0083. Argill 0,0083. Oxyde of iron 0,0083.
Opal	Silex 98,75. Argill 0,01. Oxyde of iron 0,01.
Pitchstone	Silex 73. Argill 18. Iron 6.
Ligniform Opal	Silex 0,855. Argill 0,01. Iron 0,005. Lime and magnesia 0,005. Water, inflammable matter and air 0,11.
Cat's-eye ?	
Flint	Silex 80. Argill 18. Lime 2.
Horn-stone	Silex 72. Argill 22. Carbon. lime 6.
Siliceous Schistus	Silex 75. Lime 10. Magnesia 0,046. Iron 3. Coal 5.
Horn-slate	Silex 73. Argill 24. Iron 3.
Jasper	Silex 54. Argill 30. Iron 16.
Feldspar (Adularia)	Silex 62. Argill 17. Lime 6,5. Baroselenite 2. Magnesia 6. Iron 1,4.
Labrador Feldspar	Silex 69. Argill 13. Sulphate of lime 12. Oxyde of copper 0,7. Oxyde of iron 0,04.

Petrilite.

Petrilite	
Argentine Feldspar	Silex 46. Argill 36. Oxyde of iron 16.
Feldsite ?	
Staurolite	Silex 44. Argill. 20. Baryte 20. Water 16.
Lapis Lazuli	Silex, lime, gypsum and iron.
Prehnite	Silex 44. Argill 30. Lime 18. Iron 5. Water and Air 2.
Aedelite	Silex 62 to 69. Argill 18 to 20. Lime 8 to 16. Water 3 to 4.
Zeolite	Silex 50. Argill 20. Lime 8. Water 22.
Siliceous Spar	Silex 61,1. Lime 21,7. Argill 6,6. Magnesia 5. Oxyde of iron 1,3. Water 3,3.
Rose Spar	
Adamantine Spar	Argill 66. Adamantine E. 33.
Jargon	Jargon E. 68. Silex 31,5. Iron and Nickel 0,5.
Sidneia ?	

METALS.

Metallic Arsenic	Arsenic alloyed by iron.
Oxyde of Arsenic	Arsenic and oxygen.
Sulphuret of Arsenic	Arsenic 84—90. Sulphur 16—10.
Mispickel	Arsenic, sulphur and iron.
Tungstate of Lime	Tungsten. acid 44. Lime 56.
Wolfram	Tungsten. acid 64. Oxyde of manganese 22. Oxyde of iron 13. Silex and Tin 2.

Molyb-

Molybden	Molybdic acid 60. Sulphur 40.
Carbonate of Uranite	Uranium with carbonic acid.
Menachanite	Alloyed by iron.
Grey Cobalt	Cobalt alloyed by arſenic.
Oxyde of Cobalt	Cobalt and oxygen.
Arſenicated Cobalt	
Sulphuret of Cobalt	
White Cobalt Ore	Cobalt, arſenic, iron and ſulphur.
Metallic Biſmuth	
Oxyde of Biſmuth	Oxygen and biſmuth.
Sulphuret of Biſmuth	Biſmuth 60. Sulphur 40.
Metallic Nickel	Nickel alloyed by iron.
Oxyde of Nickel	Nickel and oxygen.
Kupfer Nickel	Nickel, iron, arſenic, cobalt and ſulphur.
Metallic Mangaueſe	
Oxyde of Manganeſe	Manganeſe and oxygen.
Siliceous Ore of Manganeſe.	Oxyde of manganeſe 35. Silex 55. Iron 5. Argill 5.
Metallic Antimony	
Oxyde of Antimony	Antimony and oxygen.
Muriate of Antimony	Antimony and muriatic acid.
Sulphuret of Antimony or Grey Ore	Antimony 74. Sulphur 26.
Arſenical Antimony	Antimony and arſenic.
Red Antimonial Ore	Antimony, arſenic and ſulphur.
Plumoſe Antimonial Ore	Antimony, iron, arſenic and ſulphur.
Oxyde of Zink or Calamine	Zink and oxygen 84. Oxyde of iron 3. Silex 12.
Carbonate of Zink	Zink 60. Carbonic acid 28. Water 6. Silex 5.

Sili-

Siliceous Carbon. of Zink	Zink and carbonic acid 36. Silex 50. Water 12.
Sulphate of Zink	Zink 20. Sulphuric acid 40. Water 40.
Blende	Zink 52. Sulphur 26. Iron 8. Copper 4. Silex 6. Water 4.
Metallic Mercury	
Oxyde of Mercury	Mercury 91. Oxygen 9.
Muriate of Mercury	Mercury 70, with the muriatic and ſulphur. acids.
Cinnabar	Mercury 80. Sulphur 20.
Amalgam	Mercury and ſilver.
Hepatic Mercury	Mercury with ſulphuret of pot-aſh or ſoda.
Oxyde of Tin	Tin 80, with oxygen and iron.
Wood Tin	Tin 63, with oxygen and iron.
Sulphuret of Tin	Tin 56. Sulphur 40. Copper 4.
Tin Pyrites	Tin 36. Sulphur 26. Copper 38.
Metallic Lead ?	
Oxyde of Lead	Lead 36. Oxygen 37. Iron 24. Argill 2.
Carbonate of Lead	Lead 80. Carbonic 16.
Molybdate of Lead	
Phoſphate of Lead	Lead 73. Phoſphor. acid 18.
Sulphate of Lead	
Sulphuret of Lead	Lead 77. Sulphur 20. Silver 1.
Antimonial Lead Ore	Lead 40—50. Antimony 8—16.
Metallic Iron ?	
Grey Iron Ores	Iron and a ſmall proportion of oxygen.
Hematites	Iron with a large proportion of oxygen.

Argil-

Argillaceous Iron Ores	Iron and oxygen, carbonic acid and argill.
Spathose Iron Ore	Iron 38. Lime 38. Carbonic acid and manganese 24.
Sulphate of Iron (Vitriol)	Iron and sulphur. acid.
Sulphuret of Iron (Pyrites)	Iron and sulphur.
Metallic Copper	
Oxyde of Copper	Copper and oxygen.
Pitch Copper Ore	Oxyde of copper, with oxyde of iron.
Carbonate of Copper	Copper 73. Carbonic acid 26.
Sulphate of Copper	
Muriate of Copper	Copper 52. Acid 10. Oxygen 11. Water 12. Sand 11.
Arseniate of Copper	
Sulphuret of Copper, or Vitreous Copper Ore	Copper 56, with sulphur.
Yellow Copper Ore	Copper 20, with iron and sulphur.
Grey Copper Ore	Copper 16. Lead 34. Antimony 16. Iron 13. Sulphur 10. Silex 2. Silver 2.
White Copper Ore	Copper 40, with arsenic and iron.
Metallic Silver	
Arsenical Silver	Silver 90. Arsenic and iron 10.
Horn or Muriated Silver	Silver 67,5. Muriatic acid 21. Sulphur. acid 0,005. Iron 0,06. Argill 0,015. Lime 0,005.
Butter-milk Ore	Silver 24. Muriatic acid 8. Argill 67, with some copper.
Vitreous Silver	Silver 75. Sulphur 25.

Brittle

Brittle Vitreous Silver	Silver 66. Iron 5. Antimony 10. Sulphur 12, with a little copper and arsenic.
Red Silver Ore	Silver 60. Antimony 20. Sulphur 11. Sulph. acid 8.
White Silver Ore	Silver 20. Lead 40. Sulphur 12. Antimony 8. Iron 2,5. Argill 7. Silex 0,5.
Metallic Gold	
Grey Gold Ore	Gold, sulphur, antimony; arsenic, lead, iron, and silver.
White Gold Ore	Gold 18. Silver 0,06, with bismuth and sulphur.
Metallic Platina	

These are the Mineral bodies resulting from the combination of the primitive and elementary substances, through the law of attraction of combination. These composed bodies, which Mr. Bergman has called derivative Earths, cannot be distinguished from the more simple, as they form fossils as transparent, as regular in their forms, and as hard.

Whether several of these are not the same; and whether there are not some minerals under

under the ſame name, which are eſſentially different, muſt be determined by future analyſes. Nor ought one analyſis of a mineral to be thought ſufficient; but the ſame mineral from different countries and in different forms ſhould be examined; then the natural conſtituents of a foſſil, and the adventitious matter, would be determined, and the mineralogiſt and the chymiſt would oftener agree in the arrangement of theſe bodies. Theſe are the materials of which our globe, at leaſt its ſurface, is formed. Many of them are again mixed together; not in any chymical union, but ſimply mixed, and form various compound rocks, as Granit, which is a compound of Quartz, Feldſpar, and Mica.

CHAPTER V.

Of Stratification.

WE have ſeen how nature proceeds in forming mineral bodies; let us now attend to the manner in which they are diſpoſed; let us obſerve the rocks and ſtrata and the veins which they compoſe.

In doing this, we muſt neceſſarily go back to the period of time antecedent to their formation, antecedent to the formation of the preſent cruſt of our globe. At that time, theſe various materials were in a ſtate of ſolution in water; to a more diſtant period, and to an anterior ſtate of things, I dare not venture to aſcend. There is a point where enquiry muſt ceaſe, or be fruitleſs; which exceeded, ſpeculation runs wild, and ingenuity tramples on common ſenſe. In this ſolution, the primary elements united and

formed the various bodies we now find, ſome of which are ſtill to us elementary ſubſtances. Upon ſuch combinations, they became leſs ſoluble, and through this and other cauſes, the ſimilar particles united according to the laws of aggregate attraction, and, precipitating from their ſolution, formed our preſent rocks, ſtrata, &c. which are homogeneous or compound, according as the ſolvent held one or more kinds in ſolution, and whoſe fineneſs of grain will have been dependent on thoſe cauſes which are known to influence the ſize and ſymmetry of cryſtallizations, whilſt the thickneſs of the ſtrata will have ariſen from the quantity of the precipitate.

But I cannot proceed any further in this ſubject, without obſerving that there are two very different kinds of rock to which all may be referred, which are thoſe that are the immediate conſequence of cryſtallization, more

or leſs confuſed; and thoſe which are compoſed of the fragments, debris, duſt, or ſlime, of the former. The materials of the latter have been ſuſpended in water, as well as the former, and, when the particles have been very minute, have formed ſtrata or beds equally regular as thoſe which are the reſult of precipitation from ſolution.

The difference in the nature of the ſtrata in the ſame rock or mountain, is the conſequence of different materials, or the ſame materials of a different texture or fineneſs. As we did not enter into the enquiry whence the matter in ſolution came, we ſhall not enquire how it is, that there is ſuch variety of ſtrata in the ſame rock, nor whence it is that they alternate. Such enquiries would not only be extremely difficult, but would previouſly require a very detailed ſtatement of facts. We can eaſily ſee that it may in part depend upon the different

degrees of ſolubility of the matter, and upon the ſolutions in different places not containing the ſame ingredients; whence it would happen, that upon the ſolutions flowing into different diſtricts, they might there depoſit their contents, after a ſimilar depoſition had been covered by others of a different kind. For we muſt not ſuppoſe, that the ſtrata regularly ſurround the globe like the concentric circles of an onion; they are rather like the ſcales of the lily; rather *ſquamoſus* than *tunicatus*. Though, in general, they are of great extent when not broken and loſt, they are known to have a natural termination. In ſome diſtricts particular ſtrata are entirely wanting, and in different diſtricts they are found in a different order of ſtratification.

It is now the opinion of the beſt geologiſts, that all rocks are ſtratified. Some difference of opinion may ariſe, merely from

the imperfection of language. All rocks being formed by precipitation or subsidence, are disposed to be stratified, and, when they are composed of different kinds of depositions, are evidently so; but when they are formed of one uniform mass, the same appearances cannot exist, though equally formed by gradual deposition. For the term stratification is rather applicable to mountains or great rocks, formed of various beds of stone, than to a simple bed or rock; as we cannot say, that a stratum is stratified. If therefore a geologist should describe a rock, as not being stratified, from its not being composed of distinct beds, it by no means follows, that it has not been formed in the same manner as strata. It is probably a stratum itself; for a stratum is nothing more than a bed, which has a pretty regular thickness, with great extent in length and breadth.

Rocks and mountains have been divided into the ſtratified and unſtratified; the great Alpine rocks being ranked under the latter, and thoſe of our gentle hills and plains under the former: and there certainly is a great difference in this reſpect, between the great Alpine rocks and thoſe of our hills and plains, though it may be rather in degree than in kind. I have followed a great chain of primitive limeſtone mountains, for perhaps an hundred miles; yet they never appeared to be divided into regular beds, though they were ſome hundred yards in height. But it is well known, that ſtrata are ſometimes very thick, from finding them in the evidently ſtratified mountains. In the Carpathian mountains, I found a ſtratum of ſandſtone, about an hundred yards thick, covering ſmaller ſtrata of ſandſtone and ſchiſtus, and covered by a bed of limeſtone of equal thickneſs to itſelf; and they are

found

found from this thickneſs, and even thicker, to the thinneſs of a ſheet of paper, and extend in length and breadth through whole provinces.

In general, the more early or primitive ſtrata, which are moſtly formed by precipitation, are found in thicker beds than the more modern, which in general are compoſed of the rubbiſh and ſlime of the former by ſubſidence.

Strata are found in all inclinations, from the horizontal to the vertical. This variety of inclination may ariſe from two cauſes, either from the precipitating or ſubſiding matter falling upon an irregular ſwelling or hilly bottom or foundation, which is often the caſe I believe in the more modern ſtrata; (ſee plate 1.) or from the falling in, or giving way of the bottom or ſupport, which has happened to both the primitive and modern.

Strata have a relative age, ſome being invariably of a prior origin to others, as we may judge from their forming the foundation for thoſe which in their turn they never cover. Granit, according to the received opinion, is never found ſupported by any other rock, but is a foundation for all the others.

But many ſeem to be of cotemporary formation, which we infer from their being variouſly placed relative to one another. Thus gneis, which in general ſeems to be the next in formation after granit, alternates in Saxony with the ſaline or ſcaly limeſtone, and likewiſe with hornblend ſchiſtus, and in Bohemia reſts upon porphyry. Micaceous ſchiſtus, which is nearly allied to gneis, in the foreſt of Thuringia reſts upon porphyry. Hornblend ſchiſtus, which lies near Freyberg in Saxony between gneis

and micaceous ſchiſtus, reſts near Meiſſen on primitive limeſtone; and ſcaly or ſaline limeſtone in Saxony lies within gneis.—— Theſe belong to the primitive rocks; and though they vary in reſpect to one another, in point of priority of formation, they never reſt upon or alternate with thoſe which are particularly called the ſtratified. But theſe, which are of later formation, have amongſt themſelves the ſame relations of ſeniority and cotemporary exiſtence as the former. Toadſtone, limeſtone, coal and baſalt, ſhale and ſome kinds of ſandſtone, are variouſly placed with reſpect to one another, and alternate; but I believe there are no examples of coal and baſalt alternating with gypſum or chalk, or lying upon them.

In regard to what depth towards the centre of the earth ſtratification may extend, there can be nothing but ſuppoſition. The huge

beds or ſtrata, that are pre-eminent in the centre of great cluſters of mountains, are thoſe which in their natural ſtation would be the loweſt; and it is moſt probable, that on ſuch the more modern rocks, thoſe that are particularly called the ſtratified, reſt. Theſe in ſome parts are very numerous, and conſtitute immenſe thick beds of ſtratified matter. At Gilmerton near Edinburgh the ſtrata being much inclined, have been cut through in the proceſs of mining, and have ſhewn a bed of ſtrata above a mile in thickneſs. Mr. Williams ſays *, "The number and variety actually cut through in this field, is ſo immenſe, that it would fill a large book to enumerate and deſcribe them all. They are all what are commonly called coal metals, that is, ſtrata as are generally found to accompany beds of pit

* Williams's Hiſt. of the Mineral Kingdom, vol. i. p. 95.

coal,

coal, as whin or baſalt, limeſtone, ironſtone, and ſandſtone. There are above ſixty beds or ſtrata of coal, thick and thin, twenty of which have been worked." And according to Mr. Jones *, the iſland of Caldy near Tenby in Pembrokeſhire, where the ſtrata are vertical, ſhews a maſs of ſtratified matter two miles thick.

* Phyſiological Diſquiſitions, by W. Jones, p. 488, quarto 1781.

CHAP-

CHAPTER VI.

On Mountains, Hills, and the Irregularities of the Surface of the Earth.

WHEN ſcience has not connected the different parts of the great plan of Nature; whilſt the various concurring means to one great end, are diſtinct and inſulated; great diſorder and want of contrivance may appear, where nothing but order really prevails; and what may be the reſult of infinite wiſdom, will be conſidered as the effect of chance, and the conſequence of confuſion. No where does Nature ſeem to have acted ſo much without a plan, as in the formation of the cruſt of our globe; but we truſt that a deeper and more extended knowledge of her works, would even here induce us to reſcind the unfavourable judgment that ſhort-ſighted ignorance

ignorance may have ventured carelefsly to pafs upon her.

Such reflections are not irrelevant, previous to treating on the prefent fubject. Where indeed can greater diforder appear, than in the Alps, and in the great clufters of mountains, where the huge maffes of which they are compofed are heaped up in fuch wonderful diforder. Here it would be requifite to treat at fome length on Phyfical Geography, when many advantages might be pointed out, arifing from this diforder, independent of the facility with which we obtain fome mineral bodies of primary ufe to mankind, of which we fhould not even know the exiftence, had not the ftrata been thus broken and difplaced. Are not thefe huge piles, the fources of rivers, the refervoirs of water, the purifiers of the atmofphere, the directors of the winds, the ramparts of nations, the delightful retreats

of

of contemplation, and the elyſium of the admirers of ſublime and picturesque beauty?

Mountains and hills are the protuberant irregularities, the glens and valleys, the excavations, and the great plains, the more natural ſurface of the earth. Mountains being nothing more than rocks that have been left when the ſurrounding country ſunk down, or, as ſome think, that have been raiſed up above it, can be nothing more than ſingle beds or various ſtrata of rock, or the ruins and fragments of them.—There is no exact line of diſtinction between mountains and hills: the former appellation is more appropriate to the great elevations generally formed of the thick and primitive beds of rock; the latter to the more gentle, and compoſed of modern ſtrata or gravel. But it is the height and not the nature of the rock which gives the denomination.

Mountains are the ſublimeſt objects in nature, and the moſt wonderful; they raiſe their ſummits in ſome countries to a ſtupendous height, and cluſtered together cover whole provinces; or forming chains traverſe great empires. Chimboraſſo in South America is 3217 French toiſes above the level of the ſea; and though this indeed is the higheſt on our globe, yet the Mont Blanc, Ætna, peak of Teneriffe, and many others, are of ſurpriſing height. The chain of mountains to which Chimboraſſo belongs extends throughout South America. The Pyrenean mountains run from the bay of Biſcay to the gulf of Lyons in the Mediterranean; the Apennines through Italy; the Carpathian in a curve ſeparate Moravia, Galicia, and the Bucorine from Hungary; and the chain that ſeparates Norway from Sweden extends from the moſt ſouthern point of theſe countries to Lapland.

Theſe

These great chains and clusters of mountains, however different in their forms, and distant in situation, are composed of nearly the same materials. Granit forms the centre of them; then micaceous schistus or slate, or primitive limestone, is found, and those rocks of the earliest formation I lately mentioned; till you come amongst the gentle hills, where the thinner and more numerous strata of sandstone, limestone, &c. prevail; and it would be as fruitless a research to look for statuary marble and slates amongst the latter order of mountains, as for coal and ironstone amongst the former. From the greatest elevations, there is a more or less gradual descent to the sea, whose bottom most probably is varied with hills and valleys like the dry land.

Very few of the inequalities we have spoken of, except the gentle swells of the stratified countries, belong to the original formation

formation of the ſurface of our globe. The ſlighteſt inſpection of any of the greater mountains, will ſhew that they could never have been formed as they exiſt at preſent. Granit rocks compoſed of an aſſemblage of irregular cryſtals could certainly never have been formed in peaks; nor could the concomitant beds of gneis, ſlate, &c. have been depoſited in a vertical poſition. And though the modern ſtrata were originally formed, with elevations and depreſſions, in hills and dales, yet they likewiſe have frequently undergone conſiderable changes by falling-in, and from the effects of waters; ſo that, though originally the ſtrata roſe and fell with the hills which they compoſed, now often no idea can be formed of the direction of the former from the ſhape of the latter. Theſe alterations in the primitive direction of the ſtrata are ſo frequent, that in the mining diſtricts, where obſervations have

been chiefly made, they greatly perplex the miners, and frequently compel them to give up their purſuits.

To facilitate this ſtudy, geologiſts have reduced the mountains and hills to a ſyſtem. They have in general conſidered the granit mountains as *primary*. The gneis, micaceous ſchiſtus, ſlate, ſienit, porphyry, ſome kinds of limeſtone, ſerpentine, and a few others, as *ſecondary*. The common ſandſtone, common limeſtone, blaes, coal, and its concomitant ſtrata, as the *ſtratified*. The *Vulcanic* form the fourth claſs: and the *Alluvial*, conſiſting of gravel, clay, &c. &c. the 5th. The ſecondary are often called the Mine-mountains, (*Montagnes à filons* and *Ganggebirge*) from their being the principal field of mineral veins. Other geologiſts only make four claſſes, by uniting the primary and ſecondary, and conſidering them all as primitive.

Though the line of diſtinction, in all caſes, cannot eaſily be drawn, yet theſe diviſions are not arbitrary. In the primary and ſecondary, no remains of organic bodies are found: the ſtratified often abound with them, and their ſtratification is characteriſtic. The Vulcanic are thoſe produced by vulcanoes; and the Alluvial are the confuſed heaps which have been depoſited by the waters of floods, torrents, or rivers.

The cataſtrophes which have happened to the ſurface of the earth, in diſplacing the ſtrata in the manner we have juſt ſeen, have formed numberleſs fiſſures and crevices in the rocks; ſome of which have ſubſequently been filled up. Theſe are the veins, which we will conſider in the next chapter.

CHAPTER VII.

Of Veins.

THE great derangements I have ſo frequently mentioned to have happened to the ſurface of the earth, could not but cauſe great fiſſures and cracks in the various rocks and ſtrata that compoſe it. Many of theſe are now become mineral veins, which are ſubjects of very curious geological ſpeculation; and they are the magazines not only of the moſt beautiful, but of the greateſt variety of foſſils.

The nature and character of a vein require that it ſhould croſs the ſtrata or beds, and not run between them. Thoſe that are ſo called, and lie between and parallel with the ſtrata, ſhould rather be conſidered as mi-

nera strata than veins. They vary, as might be expected, greatly in all their dimensions and directions. They extend sometimes several miles in length, and often to a greater depth than has been reached in mining, with a breadth or thickness from a mere fissure to five or six yards or more.

Their course is generally straight, and their direction downwards, more or less vertical. Their course is not in any relation to that of the hill or mountain in which they are; though this, from the great numbers of veins, must sometimes happen. It has been the opinion of some men of experience; but it has been opposed by no less able judges. They are likewise sometimes found to follow the fall of the hill or mountain in their course downwards. They terminate in general in each direction by gradual decrease and subdivision; but they are all open at top, in the stratum in

which they are, though not through the ſuperior rocks; for frequently ſtrata have been ſubſequently ſuper-impoſed.

On the ſubject of veins being wider above than below there is a difference of opinion, probably ariſing from the obſervations having been made in different kinds of mountains. The German School conſider veins as gradually diminiſhing in width in their courſe downwards: moſt of their great mines are in what are called unſtratified mountains. The late very ingenious and moſt worthy Dr. Hutton, and Mr. Williams author of The Mineral Kingdom, juſt reverſe it, and conſider veins as wider below than above. Theſe gentlemen, I believe, have made their obſervations in the coal countries, that is, amongſt the ſtratified rocks.

It is very eaſy to conceive that veins may in this reſpect vary, and that each kind may be more or leſs peculiar to particular kinds

of rocks; for, as it is evident from various obſervations that the fiſſures in the ſtratified muſt have been formed ſubſequently to thoſe in the unſtratified or primitive; different cauſes, or the ſame cauſes acting different ways, may have produced this difference. Where the veins are wider above, the rock on one or both ſides of the vein muſt have turned *below* on its centre near the vein, by the giving way of ſome inferior rock at a diſtance from the vein. In the other caſe, the rock muſt have fallen-in where the vein is by the inferior rock given way, or elſe have been raiſed up at a diſtance from it, and have turned on its centre *above* near the vein.

On their formation as empty clefts and fiſſures, and on the manner of their being filled, geologiſts differ in opinion. As to their formation, it is eaſy to conceive that both deſiccation and forcible rupture have

concurred : indeed fissures are a natural and necessary consequence of the great derangement we find. But on the filling up of these fissures very various opinions have been given, none of which are perhaps perfectly satisfactory, and some absurd.

Before I mention these opinions, it is requisite I should describe the contents of mineral veins. They are peculiar, and are therefore not improperly called venous, or venigenous; and, exclusive of some of the neighbouring rock or rubbish which may have fallen in, they all indicate having crystallised in the solid masses or regular crystals in which we find them in the places they now occupy. On a nearer examination of a vein, we find that sometimes this venous matter is immediately united to the solid rock, which incloses and forms the sides of the vein; but in general the rock here is soft, and decomposed, and separated

from the ſparry matter and ore by an empty chink or cleft, and ſometimes by a ſemi-indurated fat clayey ſubſtance, which by the Germans is called the *Beſteg*.

The conſtituents of a vein, which are often very various, are frequently applied in different and diſtinct layers over one another, and thus indicate a ſucceſſive lateral application and formation; where the oppoſite ſides meet, cluſters of cryſtals are moſt frequently found.——Such is a mineral vein; but how they have been formed, that is, how the lapideous and metallic matter came in, and from whence it came, is ſtill to be enquired into.

For the progreſs of knowledge, unfortunately, it has happened that thoſe who were moſt acquainted with the leading facts on this ſubject were moſt incapable, from the want of ſcientific knowledge and a juſt ſpirit of philoſophiſing, to draw advantage

from

from them, and have given only proofs of the little use observation is without judgment.—Besides the opinions of veins being co-existent with their rocks, and of their being but branches of a great central mass, some have supposed that they are but the rocks themselves, changed, by powers residing in this part of nature, by a kind of internal fermentation: some, that they have been formed by the infiltration and flowing in of water from above; others, that water impregnated with different acids has dissolved and extracted this matter from the rock itself, and then deposited it in the vein; whilst others attribute their contents to vapours and exhalations impregnated with such materials rising from beneath.

Mr. Werner gives it as his opinion, that veins have been filled from above; not from any metallic or lapideous solution flowing

flowing down the sides of the vein, but by being filled at different times with the different solutions which contained the various metallic and lapideous matter we now find in them. These solutions covered at different times the districts where the veins are found, in the same manner as we suppose the solutions did from whence the different beds or strata were formed, they being both formed by the precipitation of the matter of which they are composed, from their solvents. Thus veins and strata are formed in the same manner; and the first differ from the latter only by their situation: and in the same manner as we attribute any number of strata to as many successive precipitations and depositions, naturally believing the lowest to be the first in priority of formation, so he attributes the different contents of a vein to different precipitations, considering that kind of ore or lapideous matter

which

which is next to the rock as the oldeſt or firſt formed: he gives an example of a vein conſiſting of 13 or 14 different depoſitions on each ſide, chiefly of fluor, calcareous ſpar, heavy ſpar, and galena.—But a vein is not to be conſidered to have been filled with its preſent various contents from one ſolution only, but in many caſes from ſeveral and at different times; though in ſome the precipitations may have been at one or ſeveral times from one ſolution only, as one ſolution may have contained different ingredients; and as one vein may have been formed by different impletions, ſo diſtant veins of the ſame kind of ore &c. may have been formed by the ſame ſolutions, and at the ſame time.

This learned mineralogiſt has given an account of eight different formations of Ore, in the diſtrict of Freyberg where he reſides.

The

The first and oldest is the Galena Lead Ore, holding from $1\frac{1}{2}$ to 2 ounces of Silver, accompanied by

Arsenical Pyrites,

Black Blende,

Common and Liver Pyrites,

Copper Pyrites,

Spathous Iron Ore. Having for its Veinstones (Gangarten),

Quartz,

Pearl Spar, and

Calcareous Spar.

The second is Galena, very rich in Silver, accompanied by

Black Blende,

Common and Liver Pyrites, and mostly with a little Arsenical Pyrites,

Red Silver Ore,

Brittle Vitreous Silver Ore,

White Silver Ore. Having for its Veinstones

Quartz,

Pearl Spar, and

Calcareous Spar.

The third is Galena, holding about an ounce of Silver, accompanied by

Common Pyrites,

Black Blende,

Red Iron Ochre. Having for its Vein-ſtones

Quartz, and a little

Chlorite Earth.

The fourth is a Galena, holding from a quarter to half an ounce of Silver, accompanied by

Pyrites (Strahlkies). Having for Vein-ſtones

Heavy Spar,

Fluor,

Quartz, and

Calcareous Spar. With this formation another is generally combined, which is compoſed of

Grey Copper Ore,

Copper

Copper Pyrites, and

Galena. Having for Vein-ſtones a

Quartzous Petroſilex,

Heavy Spar, and

Fluor.

The fifth is compoſed of

Native Silver,

Vitreous Silver Ore,

White Cobalt Ore,

Grey Copper Ore,

Galena, very rich in Silver,

Brown Blende, and

Spathous Iron Ore. Having for Vein-ſtones

Heavy Spar, and

Fluor.

The ſixth is Native Arſenic,

Red Silver Ore,

White Cobalt Ore,

Native Silver,

Galena,

Pyrites and

Spathous Iron Ore. Having for Vein-
ſtones

Heavy Spar,

Fluor,

Calcareous Spar, and

Pearl Spar.

The ſeventh is Hematites, and Eiſenglanz, (Ferrum Speculare). Having for Vein-ſtones

Quartz, and

Heavy Spar.

The eighth is Copper Pyrites,

Mountain Green Copper Ore,

Malachite and

Red and Brown Iron Ochre. Having for
Vein-ſtones

Quartz, and

Fluor.

He mentions likewiſe about 20 different formations of the Galena Lead Ore, conſidering

dering that which accompanies copper pyrites and gold, having quartz for its veinſtone, which is found in the diſtrict of Salzburgh, as the oldeſt; and that of the lateſt formation, which is found in veins in the coal ſtrata, and even in the coal itſelf.

The principal objection to this theory, I think, is this; that if the empty veins were filled with a fluid that held in ſolution the ingredients now forming them, and which then covered the rocks in which we find them, it is reaſonable to expect that ſimilar depoſitions and precipitations ſhould have taken place in their neighbourhood, which was likewiſe covered by ſuch fluids; and that conſequently we ought to find beds or ſtrata of the ſame at the mouths, as I may ſay, and in the proximity of ſuch veins. This cannot be denied; and Mr. Werner ſays, that we do find almoſt all the venous foſſils forming theſe extended depoſitions in the

 ſame

ſame mountains; and attributes their ſuppoſed infrequency not to their non-exiſtence, but to the want of proper obſervations, and to the ſcanty knowledge we have of our globe. Such is the theory of the celebrated Profeſſor of the Freyberg School.

Opinions founded upon obſervation ſhould always be treaſured up, even though, from being in oppoſition to better grounded opinions, we ſhould be led to reject them: future advances in knowledge may accord the ſeemingly inconſiſtent facts on which they are grounded, and apparently oppoſing ſentiments may one day confirm each other. Mr. Trebra, a man of great experience, and director of our Sovereign's mines in the Harze, ſupports his opinion of veins being filled by mineral vapours and exhalations formed by the changes and fermentations that take place within the bowels of the earth, and in the mines themſelves, by an

obſervation he made in a mine at Andreaſ-berg, in the Harze, which he mentions in his *Mineralien Cabinet*, p. 77: here he obſerved that the cryſtals which had formed themſelves on other cryſtals were only on the under ſide, as if they had been formed by ſublimation from below, not from precipitation from above. But Mr. Werner * ſays, he has frequently examined them in their natural ſituation, and has always found them on the upper ſide.

When we reflect, that in the preſent ſtate of chemical knowledge we can decompound, and reduce into the ſtate of vapour and gas, many ſolid bodies; and in our own laboratories can form ſolid and concrete bodies out of gaſſes; though we ſhould not eagerly adopt ſuch opinions, merely becauſe they are poſſible, we ought not to reject them with contempt. Mr. Trebra like-

* Neue Theorie von der Entſtehung der Gänge.

wiſe obſerved in a mine at Marienberg, native ſilver and vitreous ſilver ore thinly depoſited upon ſome wooden ſupports which had been placed in the mine about two hundred years before: this confirms him in the opinion of the continued formation of the minerals which fill the veins.

I have chiefly ſpoken of thoſe veins which contain ores and minerals almoſt peculiar to them, as they are the moſt important, and we are beſt informed concerning them: but there are others which are filled with ſome kinds of ſtone, that frequently form great rocks and ſtrata. Mr. Werner ſpeaks of veins of granit, at Johan-Georgenſtadt, in micaceous ſchiſtus. I have ſeen ſimilar veins of granit at Invercauld in Scotland, in primitive compact limeſtone, and in granulated quartz or primitive ſandſtone. At Marienberg, he ſays, there are veins of porphyry; in the

Oberlausiz, veins of coal, and which Mr. Williams says he has seen in Scotland. In the canton of Berne there are veins of salt; and veins of wacke and basalt are very common both in Germany and in our own island.

Though, from the formation of veins as well as strata being so long antecedent to every human record, we neither know nor ever can know when they were formed; yet of their relative age we possess some few data to reason from. In regard to the antiquity of the beds and strata, we reasoned from their super-imposition to one another. We have not less certain data, though they are but few, to decide on the relative antiquity of veins. Those veins that are found in the primitive rocks must necessarily be of prior formation to those which are found in the stratified that cover them, which did not exist till after the for-

mation of the veins in the former: this is evident from their not having been broken through when these veins were formed. There is likewise a priority of formation even amongst those which are found in the same rock. This is ascertained by their crossing one another. Thus for instance, if vein A is cut across by vein B, and B is crossed by vein C, it is evident that C is the last and A the first formed. It is thus we know that veins of wacke and basalt are of the latest formation. Further, there is not only a relative antiquity or seniority between the veins, but likewise between different kinds of ore and vein-stones. Tin, molybden, tungsten, and wolfram are amongst the most ancient, then uranite and bismuth: these are never found in the stratified rocks. Then gold and silver. Quick-silver, copper, lead, and zink, have each been formed at many different times.

Cobalt and kupfer nickel are of later formation. Different kinds of iron are of different formations. The ferrum attractorium or grey iron ores are the oldeſt, then the red iron ores, then the brown and ſpathous iron ores. The iron-ſtone is of ſtill later formation, and the ſwamp iron ore is lateſt of all.

CHAPTER VIII.

Of Petrifactions.

IN a geological point of view, there is no part of mineralogy more interesting than the organized bodies which are found in different states in many of our rocks and strata. They are indeed justly considered as the medals and antiquities, from which the history of our globe must be drawn.

They are not mere curiosities thinly scattered here and there. The most internal parts of continents, now hundreds of miles from the sea, and mountains of great height equally distant, not only contain such bodies as are exclusively the inhabitants of the sea, but seem even composed of them: immense beds of limestone are to be found in most parts of Europe full of them; and

other remains of life and vegetation are not less abundant in other strata.

Though most organized bodies that are found buried in the soil, or in strata, are commonly called petrifactions; yet those only ought to receive this appellation which have by some process changed their animal or vegetable natures, and acquired that which is peculiar to the mineral kingdom. It is not difficult to conceive how a vegetable body, after having, by a partial decay, lost its particular juices and parenchymatous substance, may have been penetrated by siliceous or other lapideous matter; but it is extremely difficult to conceive how shells and similar bodies should, without losing their form, lose their natural texture, and acquire the spathous texture which is so very common.

Particular kinds of strata have their peculiar kinds of organic bodies: and as shells

and the lithophyta are peculiar to limestone ſtrata, and fiſhes to ſome particular kinds of ſlate; ſo vegetable bodies are peculiar to the ſandſtone and argillaceous ſtrata which accompany the coal, whilſt the remains of hot-blooded animals are found in the alluvial ſtrata. It would be a fruitleſs ſearch to look for the remains of organic bodies in the primitive rocks; and not leſs ſo to ſearch for the ſhells of the limeſtone ſtrata in thoſe that accompany coal; or the vegetables of the latter in thoſe of limeſtone.

Beſides the difference in reſpect to the various kinds of organic bodies, which are now found imbedded in ſtrata, they differ greatly with reſpect to the ſtate which they are in;—ſome being ſtill in their natural and original ſtate, as moſt of the oſſeous remains of hot-blooded animals; the remains of ſome of the cruſtaceous animals, and ſome ſhells.

ſhells. Some are charred or turned into coal, as moſt vegetables found in the ſtrata accompanying coal. Some are turned into calcareous ſpar, as moſt ſhells; others into different kinds of agate and ſilex, as moſt woods; and others are turned into pyrites. Theſe different ſtates depend, I believe, on the nature of the body in which they were imbedded, as I have obſerved wood in a ſtate of petroſilex imbedded in petroſilex, and ſhells in a ſtate of calcareous ſpar, in limeſtone; whilſt ſimilar ſhells lying in a ſoft marle, between the ſtrata of the ſame limeſtone, were only decompoſed and not at all petrified.

No part of mineralogy is fuller of falſe or erroneous facts, to uſe a Scotticiſm, than this, and on this account it is very difficult to treat on the ſubject. The greater part of what paſs under the name of petrifactions, are either merely impreſſions or nuclei or

incrustations, so that any general doctrines founded upon common observations would be very liable to be erroneous, and I have now no collection to consult. I can therefore say but little on this very interesting subject. I do not recollect having seen any osseous remains of hot-blooded animals, that had lost their natural texture and assumed a spathous texture; but I have seen their cells and pores filled with lapideous and pyritical matter: but in general they are either in their natural and original state, or they have lost the gelatinous connecting medium of the calcareous matter, and are decomposed. But shells, crustaceous animals, and lithophyta, the common productions of the sea, though often found in their natural state or decomposed, are generally real petrifactions. They are perhaps always calcareous, though their moulds and impressions are often siliceous, and likewise their perforations

rations and vacuities. The ſiliceous are the inverſe of the calcareous. Thus the entrochites in a calcareous ſtate are what mechanics call female ſcrews, having the worm within a hollow cylinder; whilſt thoſe that are ſiliceous, which are found in a kind of petroſilex, are male ſcrews, having the worm round the outſide of a ſolid cylinder. The firſt is the real ſhell converted into ſpar, or with a ſpathous texture; the latter, the mould formed within the cavity of it. Vegetables are found merely charred, or penetrated with bitumen, or changed into coal; often likewiſe ſo completely penetrated with ſiliceous matter as to form a ſolid ſiliceous maſs; but they are never converted into a calcareous body, though I have found ſome, that, being mixed with calcareous earth, efferveſced with acids.

There are two things further to be conſidered relative to organic remains, which,

as

as far as petrifactions are to be consulted as the records of past events, are worthy of deep attention. First, that of the far greater part there are now no similar species existing; and secondly, that of those which do, the greater part do not now exist in the countries in which they are found. If we go back to a remoter period than that when the alluvial and superficial covering of the earth was deposited, to that period at which the greater part of our stratified rocks were formed, we shall find that almost another creation then existed, of which our present strata have been the cemeteries.

Of the myriads of belemnites, cornua ammonis, lapis numularis, encrinites, &c. &c. which are to be seen in them, none now are ever found in our seas, or the seas of other parts of the world. Some Naturalists so far extend the opinion, of most of the inhabitants of the seas of that

remote

remote period being now extinct, that they will hardly admit there is a single fossil shell which will bear a strict comparison with any species now living. It is the same with the vegetable world. Though there are many fossil species very similar to species still in existence, yet few, I believe, will bear a nice examination. In the same argillaceous and sandstone strata, in which we find some plants of the filix tribe, very similar to those now growing near the spot where these lie buried, we find others, of whose original we cannot form the smallest idea, which we are certain cannot be found in the neighbourhood, and which most resemble some plants of the tropics.

If we descend to times which approach nearer our own, and examine the alluvial strata, we find the remains of animals in their natural state, which likewise are not, and most probably never were, inhabitants of the countries in which they are now found.

found. In the coldeſt parts of Europe, as in Siberia, the remains of elephants and rhinoceroſes, animals peculiar to the hotteſt parts of Aſia and Africa, are found; and in ſome few parts the remains of an animal greatly ſuperior to them in bulk, and now extinct: ſo great have been the changes on the ſurface of the earth.

Many ingenious and learned men have attempted to explain the cauſes of theſe changes, but with ſucceſs by no means adequate to their ardour in the enquiry. I will ſo far profit by their errors as to remain ſilent on the ſubject. Thoſe who wiſh for proofs of the raſhneſs, incapacity, and errability of the human intellect, and who may want examples of great abſurdities from the pens of learned men, may read with great advantage and ſome amuſement, the Theories of the celebrated Des Cartes, Burnet, Whiſton, Buffon, &c. &c.

CHAPTER IX.

On the exterior Characters of Minerals.

I HAVE hitherto been treating of thoſe doctrines which principally concerned the intrinſic and eſſential nature of the objects of our ſtudy. We muſt now conſider their external qualities.

All knowledge would be uncertain, and all experience uſeleſs, were not certain qualities invariably united. We are obliged implicitly to confide in this regularity of nature, and compelled to judge from ſome few ſuperficial appearances, of the intimate properties of bodies; for the external appearances are the natural ſigns or characters by which we recogniſe thoſe objects whoſe intimate and intrinſic qualities are already known to us. Independent of this conſidera-

tion, ſome of the external characters of foſſils are the qualities by which they moſt intereſt us. It is then a folly to reject their uſe, and rely ſolely on chemical characters for our knowledge of them.

Chemiſtry of late years has made a moſt rapid progreſs, and every branch of knowledge within its reach has been advanced by it. Mineralogy ſhould be the firſt to ſpeak its eulogium as the ſmall tribute of gratitude for great favours; but ſhould be cautious, leſt in its zeal it ſhould attribute to it powers it never poſſeſſed, and expect from it kind offices it never can perform. Chemiſtry has done much for mineralogy: it has raiſed it from a frivolous amuſement to a ſublime ſcience; and ſtill continuing its enlightening aid, will in time, with the progreſs of ſcience, bring to light many things that now lie concealed, and unveil many of the hidden myſteries of nature. But every

ſcience, when it becomes the prevailing one of the day, is in great danger of being extended beyond its natural powers, and to objects beyond its reach. Every one who has attended to the progreſs of the ſciences will admit this, without my bringing to his recollection the abſurdities which formerly were ſo often the reſult of the ſtupendous calculations of the moſt ſublime mathematical geniuſes; and it is humiliating to reflect, that the greateſt men have been carried away in the current of the falſe opinions of the day, and have by their names, and often by their writings, contributed to render error reſpectable, and ſtop the progreſs of ſounder opinions.

Many have wiſhed mineralogy to be treated merely as a branch of chemiſtry, and were willing to reject every aid but what this ſcience affords: they have attended ſolely to the chemical characters, and have

rejected their natural ones. But had they not been blinded by prejudice, they muſt not only have acknowledged that mineral bodies, in common with others, poſſeſs qualities which are evident to our ſenſes; but that they themſelves, whilſt they pretended to depend wholly upon chemiſtry for their knowledge of them, did in fact conſult their external properties. For though the chemiſt may ſay that we can only know the chemical properties of minerals through the aid of chemiſtry; yet he ſhould recollect that he only knows by this means thoſe of the *individual and identical* ſpecimen he has analyſed and deſtroyed; and that whenever he attributes the ſame chemical properties to another individual or ſpecimen of the ſame kind, he makes uſe of its external qualities as ſigns or criteria, and conſequently admits their utility, in judging of the eſſential or chemical properties; truſting to the regularity

regularity of nature in the conſtant concomitancy of certain external ſigns with the eſſential natures of bodies. *The external characters of minerals have, then, been always attended to, though no rules may have been given for the uſe of them, and though no language may have been formed to expreſs them.*

The great advantage of external characters muſt appear upon reflecting on the trouble and difficulty attending a chemical analyſis; which requires not only a conſiderable ſkill in chemiſtry, but a laboratory, and always the deſtruction of the thing examined. Beſides, as I have ſaid before, minerals have many properties worthy of notice, either on account of their utility, or as ſubjects of ſpeculation, independent of thoſe which are made known by chemiſtry, or which are in any wiſe to be learnt by its aſſiſtance. It is therefore fit that theſe properties ſhould be reduced into ſyſtematic

order, that they may be more easily attended to; and that a scientific language should be formed by which they may be expressed, by which we may converse, and through the medium of which we may hand down our observations to posterity.

A close and critical attention to the external characters gives us a knowledge of them far beyond that of common observation, and renders a peculiar language, copious and precise, one equal to the extent of our ideas, necessary. This has been found requisite in the other branches of natural history; and indeed in every science, and cultivated branch of knowledge, even to the common arts; for common language is too poor and vague, and must be increased by the introduction of new words and new terms; for means of expression must always be proportioned to the extent of our ideas, and in their

progressive increase must keep pace with them.

This scientific or technical language appears at first pedantic; and superficial men, not seeing its utility, have taken advantage of its being an unpleasant study, and have ridiculed it as an unnecessary farrago of hard words. We need only be cautious not to multiply the terms beyond the reach of definition, and not expect a perfect knowledge of this scientific language without a knowledge of the subject.

Minerals, then, besides their intrinsic and essential qualities, dependent on their constituent principles, which I treated of in the first part of this work, possess others arising from the disposition and mode of arrangement, &c. of their parts; such as, external form, internal texture, cohesion, transparency, lustre, density, colour, feel and sound. These, with those dependent on their constituent

principles, as ſolubility, fuſibility, phoſphoreſcence, magnetiſm, volatility, inflammability, efferveſcence, &c. &c. &c. and in their different degrees, and variouſly concomitant, afford a multitude of characteriſtic differences for the diſtinguiſhing and deſcribing of foſſils.

The Wernerian School have carried this attention to the outward characters far beyond all others, and have formed a language to expreſs them. It is ſo much for the advantage of ſcience that one uniform terminology ſhould be uſed, that I ſhall in general adopt theirs: yet as writing in another language, I muſt occaſionally differ from them to conform to the genius of the one I uſe. However, in conſidering regular cryſtals, I cannot avoid preferring the method of Mr. Romé de Liſle to that of Mr. Werner; as in the former more attention is paid to the particular forms and angles than to the general

appearance, which is chiefly attended to by the latter: and in tracing the different variations or varieties of cryſtals up to the more ſimple or primitive forms, this method is moſt convenient, and in their claſſiffication more natural.

The characters come in the order in which they ſhould be ſought for in a foſſil according to the Wernerian method, and in the order in which the deſcriptions of this ſchool are given.——Though I have made ſome objections, in my tenth chapter, to the order of the characters in the deſcriptions, diſapproving of their beginning by their leaſt characteriſtic qualities, as colour and accidental ſhapes; yet I perceive, were I to throw theſe further backward, other inconveniences would be the conſequence.——The characters belonging to each of the three different ſtates of cohesion, as *ſolid*,

friable,

friable and *fluid*, are placed under their respective heads; but the colours being common to all the three are placed first.

The COLOURS, Colores, Die Farbe*, are,

The Whites.

Snow White Niveus Schneeweiss	Pure White, as the Marble of Carara and the Flos-ferri.
Reddish White Albo-rubescens Rothlichweiss	White with a light tint of Red, as some Calcareous Spars from Andreasberg in the Hartze, and the Quartz Crystals of Schemnitz in Hungary.
Yellowish White Albo-flavescens Gelblichweiss	White with a light tint of Yellow. Examples, in Stalactites and many Calcareous Spars, &c.
Silver White Argenteus Silberweiss	The same as the preceding, only of a Metallic Lustre. Examples, Native Silver, Native Bismuth, Arsenical Pyrites, and Mica.
Greyish White Albo-griseus Grünlichweiss	White with a light tint of Black. Example, in Limestone.
Greenish White Albo-virescens Grünlichweiss	White with a light tint of Green. Examples, in the White Amianthus, Stralstein, Tremolit, and Talc.
Milk White Lacteus Milchweiss	White with a light tint of Blue. Examples, in the White Opals, Amianthus, Schiefer Spar, &c.
Tin White Stanneus Zinnweiss	The same as the preceding, only of a Metallic Lustre. Examples, Native Antimony, Antimonial Silver Ore, and White Cobalt Ore.

* The terminology is in three languages, English, Latin, and German, for reasons given in the Introduction.

Greys

Are the Mixture of White with ſome Black.

Lead Grey Plumbeus Bleigrau	Grey with a little Blue, and a Metallic Luſtre. Examples, Galena, Grey Antimony, Molybden.
Blueiſh Grey Griſeo-cœruleſcens Bläulichgrau	Is nearly the ſame as the preceding, only without the Metallic Luſtre. Examples, in Chalcedony, Petroſilex, Clay, Schiſtus, Marle, and Limeſtone.
Pearl Grey Margaritaceus Perlgrau	Is a light Grey with a little Red and leſs Blue. Examples, Horn Silver, Quartz, Chalcedony, &c.
Soot Grey Infumatus Rauchgrau	Is a pretty dark Grey with a little Blue and Brown. Examples, in Flints, Petroſilex, Limeſtone, &c.
Greeniſh Grey Griſeo-vireſcens Grünlichgrau	Is a light Grey tinged with Green—a rare colour in Minerals. Examples, in ſome Slates, Serpentines, and Jaſper.
Yellowiſh Grey Griſeo-flaveſcens Gelblichgrau	Is a light Grey tinged with Yellow. Examples, in Spathous Iron Ore, Limeſtone, Marle, &c.
Steel Grey Chalybeus Stahlgrau	Is a dark Grey with a light tint of Yellow, and a Metallic Luſtre. Examples, in Iron-Glimmer, Radiated Manganeſe, and the Grey Copper Ore.
Black Grey Griſeo-nigreſcens Schwärzelichgrau	Is the darkeſt Grey with a tint of Yellow. Examples, in Slate, Petroſilex, Lapis Suillus, &c.

Blacks.

Greyiſh Black Nigro-griſeus Graulichſchwarz	Is Black with a little White. Examples, Baſalt, Baſalt-Hornblende, Lapis Lydeus, ſome Flints, Slates, and Limeſtones.
Browniſh Black Nigro-fuſcus Bräunlichſchwarz	Is Black with a tint of Brown. Examples, in Wolfram, Tin Ore, and Blende.

Black

Black Niger Dunkelschwarz	Is the pure Black. Examples, in Obsidian, Coal, Shorl, Glimmer, &c.
Iron Black Ferreus Eisenschwarz	Is the same as the preceding, only with a small mixture of White, and of a Metallic Lustre. Examples, Magnetic Iron, and Brittle Vitreous Silver Ore.
Blueish Black Nigro-cœrulescens Blaulichschwarz	Is Black with a tint of Blue. Example, Black Cobalt Ore.

Blues.

Indigo Blue Cœruleo-nigrescens Indig Blau	Is dark blackish Blue. Examples, Native Prussian Blue and Sapphire.
Prussian Blue Cœruleus Berliner-blau	Is the purest Blue. Examples, Sapphire, and the Blue Rock Salt from Upper Austria.
Azure Blue Lazureus Lasur-blau	Is a bright Blue with scarce a tint of Red. Examples, Lapis Lazuli, and the Azure Copper Ore.
Smalt Blue Smaltinus Schmalte-blau	Is a light Blue. Example, the Natural Prussian Blue.
Violet Violaceus Viol-blau	Is the mixture of Azure Blue and Carmine. Examples, Amethyst and Fluor.
Lavender Blue Lavendulaceus Lavendel-blau	Is the preceding mixed with Grey. Examples, the Porcelain Jasper, Lithomarga, Fluor.
Sky Blue Cœlestis Himmel-blau	Is a light Blue well known. Examples, the Turquoise, the Feldspar of Krieglach in Styria, Siberian Beryl, and some of the Azure Copper Ores.

Greens.

Greens.

Verdigris Green Æruginosus Span-grün	Is a bright Green of a Blueish cast. Examples, Mountain Green, Copper Ore, and some Malachite.
Sea Green Thalassinus Seladon-grün	Is a very light Green, which is a mixture of the preceding with Grey. Examples, in Beryls, Fluor Spars, and the Terre Verde of Verona.
Beryl Green Beryllius Berg-grün	Is like the preceding, but of a Yellowish cast. Examples, Aqua Marine, most of the Siberian Beryls, some of the Glassy Stralsteins, and Asbestus.
Emerald Green Smaragdinus Smaragd-grün	Is the purest Green. Examples, Emerald and Fluor, and some varieties of the Malachite.
Grass Green Gramineus Grass-grün	Like the preceding, but with a slight tint of Yellow. Examples, the Chalkolith, and some Malachites.
Apple Green Pomaceus Apfel-grün	Is a light Green, formed of Verdigris Green and White. Examples, Chrysoprase, Prehnite, the Kosemütz Opal, and the Ochre of Kupfer Nickel.
Leek Green Prasius Lauch-grün	Is a very dark Green with a cast of Brown. Examples, Jade, Heliotrope, Prase, Asbestus, Green Stralstein.
Blackish Green Viridis-nigrescens Schwärzlich-grün	The darkest of the Greens, a mixture of the preceding with Black. Example, Serpentine.
Pistachio Green Pistachius Pistachien-grün	Is a mixture of Grass-green, Yellow, and a little Brown. Examples, Chrysolite, some Garnets, and the Glassy Stralstein of Bourg d'Oisong.
Olive Green Olivaceus Oliven-grün	Is a yellowish Green, with a tint of Brown. Examples, some Pitchstones, Garnets, and Arsenical Copper Ore.
Asparagus Green Asparaginus Spargel-grün	Is the lightest of the Greens, and is Yellowish, mixed with a little Brown and Grey. Examples, the Chrysoberyll and some of the Green Lead Ores.

Siskin

Siskin Green Viridis-flavescens Zeisig-grün	Is a very light Yellow Green, nearly an equal mixture of Emerald Green and Lemon Yellow. Examples, in the Green Lead Ores, Chalkolith and the Steatites of Zöblitz.

Yellows.

Sulphur Yellow Sulphureus Schwefel-gelb	Is a light Greenish Yellow. Examples, Native Sulphur and some Serpentines, &c.
Brass Yellow Aurichalceus Messing-gelb	Like the preceding, only a little less of a Green cast, and of a Metallic Lustre. Examples, Copper Pyrites, and one variety of Native Gold.
Lemon Yellow Citrinus Zitron-gelb	Is pure Yellow. Examples, in Lead Ores, Orpiment, &c.
Gold Yellow Aureus Gold-gelb	Like the preceding, but with the Metallic Lustre. Examples, Native Gold and some varieties of Copper Pyrites.
Honey Yellow Melleus Honig-gelb	Is a pretty deep Yellow formed of a mixture of Sulphur Yellow, with some Reddish Brown. Examples, in Amber, Fluors, and Calcareous Spar.
Wax Yellow Cereus Wachs-gelb	Is the preceding with a small mixture of Grey? Examples, the common Opal of Telkobania, and some Lead Ores.
Pyritaceous Pyritaceus Speis-gelb	Is a Pale Yellow with Grey, and much like the preceding, only with a Metallic Lustre. It is almost peculiar to Common Pyrites.
Straw Yellow Stramineus Stroh-gelb	Is a Pale Yellow, a mixture of Sulphur Yellow and Reddish Grey. Examples, in Antimonial Ochres, and Yellow Cobalt Ochre, and the Porcelain Jaspis of Bohemia.
Wine Yellow Vinaceus Wein-gelb	Is a Pale Yellow with a tint of Red. Examples, in the Saxon Topaz, Calcareous Spar and Fluors.

Ochre

Ochre Yellow Ochraceus Ocker-gelb	Is a darker Yellow than the preceding. It is a mixture of Lemon Yellow with a little Brown. Examples, in Iron Ochres and Calamine.
Isabella Yellow Isabellinus Isabell-gelb	Is a pale Brownish Yellow. A mixture of pale Orange with Reddish Brown. Examples, in Calamine, Mountain Cork, and the Yellow Spathous Iron Ore.
Orange Yellow Aurantiacus Oranien-gelb	Is a bright Reddish Yellow, formed of Lemon Yellow and Red. Examples, in the Siberian Red Lead and in Orpiment.

Reds.

Aurora Red Auroreus Morgen-roth	Is a bright Yellow Red, a mixture of Scarlet and Lemon Yellow. Examples, in Orpiment and the Siberian Red Lead.
Hyacinth Red Hyacinthinus Hyacinth-roth	Is a high Red like the preceding, but with a tint of Brown. Examples, the Hyacinth, Red Copper-Ochre, &c.
Brick Red Lateritius Ziegel-roth	Is a lighter Red than the preceding, and is a mixture of Aurora Red and a little Brown. Examples, in Red Copper Ochre, Zeolite, and a variety of the Porcelain Jasper.
Scarlet Red Purpureus Scharlach-roth	Is a bright and high Red, with scarce a tint of Yellow. Examples, in some Cinnabar Ores.
Copper Red Cupreus Kupfer-roth	Is a light Yellowish Red, with the Metallic Lustre. Example, Native Copper.
Blood Red Sanguineus Blut-roth	Is a deep Red, a mixture of Crimson and Scarlet. Examples, the Bohemian Garnets, some Red Silver Ore, &c.
Carmine Red Carmineus Karmin-roth	Is the purest Red verging towards a cast of Blue. Examples, in the Red Copper Ores, and the Cinnabar of Rosenau.

Cochineal

Cochineal Red Coccineus Kochenill-roth	Is a deep Red; a mixture of Carmine with a little Blue and a very little Grey. Examples, the Ruby and some Cinnabars.
Crimson Red Carmosinus Kramoisin-roth	Is a deep Red with a tint of Blue. Examples, in the Oriental Garnets and Rubies, and the crystallized Cobalt Ochre.
Flesh Red Carneus Fleisch-roth	Is a very pale Red of the Crimson kind. Examples, Feldspar, and Heavyspar.
Rose Red Roseus Rosen-roth	Is a pale Red of the Cochineal kind. Examples, the Rose-coloured Quartz of Bavaria and Siberia, and the Siliceous Ore of Manganese from Kapnic.
Peach Blossom Red Dilute-carmosinus Pfersichblüth-roth	Is a very pale Red of the Crimson kind. Example, Cobalt Ochres.
Mordoré Carmosinus-fuscus Mordoré-roth	Is a dark dirty Crimson Red; a mixture of Crimson and a little Brown. Examples, the Red crystallized Antimony from Saxony, and the Red Iron Glimmer (Eisen Ram), and the Tinder Ore from Clausthal.
Brownish Red Fusco-ruber Bräunlich-roth	Is a mixture of Blood Red and Brown. Example, in Jaspers.

Browns.

Reddish Brown Fusco-rubescens Röthlich-braun	Is a deep Brown inclining to Blood Red. Example, Brown Tin Ore, and Brown Blende.
Clove Brown Caryophyllinus Nelken-braun	Is a deep Brown with a tint of Carmine. Example, smoked Topaz, the compact Brown Iron Ore, and the Brown Spathous Iron Ore.
Yellowish Brown Fusco-flavescens Gelblich-braun	Is a light Brown verging to Yellow Ochre. Examples, some varieties of Iron Ochre, Jasper, and Bog Iron Ore.

Umber Brown Umbreus? Holzbraun	Is a light Brown, a mixture of Yellowish Brown and Grey. Examples, Ligniform Asbestus, Bovey Coal.
Hair Brown Capillaceus Haar-braun	Is an intermediate between Yellow Brown and Clove Brown with a tint of Grey. Example, in the Wood Tin of Cornwall.
Tombac Brown Tombacinus Tomback-braun	Is a light Yellowish Brown, and of a Metallic Lustre, formed of Gold Yellow and Reddish Brown. Examp. the Brown Mica.
Liver Brown Hepaticus Leber-braun	Is a dark Brown; Blackish Brown with a tint of Green. Examples, in some Jaspers, and now and then the Brown Cobalt Ochres.
Blackish Brown Fusco-nigrescens Schwärzlick-braun	Is the darkest of the Browns. Examples, in the Onyx, the Elastic Bitumen, some of the Bog Iron Ores, and Bituminous Wood.

As Colours vary much in intensity, there are four degrees: the *Dark*, *Deep*, *Light* and *Pale*. When a colour cannot be referred to any of the preceding, but is a mixture of two of them, this is expressed by saying, the prevailing one *verges* to the other, if only in a small degree; *passes* into it, if in a greater; and if it is the medium between the two, it is said to be between them.

The Tarnish or Superficial Colours. Die Angelaufenen Farben.

Minerals are frequently found with their mere surfaces differently coloured from their interior, as though they were tarnished; yet in general of splendid Colours. Sometimes these Colours are uniform, that is not mixed; but frequently several are found together, and this is called being variegated. There is the

Peacock's Tail Tarnish Pavoninus Pfauenschweifig	Which is the most Brilliant. Here Brown, Blue, Green and Yellow are the prevailing Colours, and are softly mingled

gled

gled in Spots. Examples, on Copper Pyrites, and the Specular Iron Ore of Elba.

Rainbow Tarnish Iridinus Regenbogenfarben	Here the Blue, Red, Yellow and Green are in streaks, which insensibly run into each other. Examples, in Galena, and the Grey Ore of Antimony.
Pigeon-breast Tarnish Columbinus Taubenhälsig	Here Blue, Green, and a little Red and Yellow, are softly mixed together. Examples, in Native Bismuth, and the Variegated Copper Ore.
Steel Tarnish Chalybeus Stahlfarbig	Is the feeblest of the Variegated Colours, and is principally Blue and Yellow running into one another.

The Play-colours. Die Farben Spiel.

Are the Variegated Colours sometimes observed in the more or less transparent Fossils when they have a crack or flaw, as now and then in Rock Crystal.

The Opalising Colours. Versicolores. Die Farbenverwandlung.

Some Fossils have the property of reflecting different Colours according to the relative position of the eye and the object. In some it is on the *Surface*, as in the Labrador Feldspar, as it is called, and the Carinthian Lumachella. In others, internal, as in the Opal.

Dispositions of Colours.

For the sake of brevity, some Dispositions of Colours are expressed by Names, as

Nebulous Nebulosus Wolkigt	When a colour is not in the same degree throughout, but is in some parts lighter or darker than in others.
Spotted Maculatus Gefleckt	With spots of a colour different from the ground. The colours may be various.

Dotted

Dotted Punctatus Punctirt	With specks and dots on a ground of a different colour, as in the Heliotrope.
Streaked Lineatus Streifigt	When streaks of different colours are found together, as in some Marbles, the Streaked (band) Jasper.
Ringed Annulatus Ringförmig	When colours are in rings or circles, as Agates.
Dendritical Arborescens Baumförmig	When imitating trees, as in some Marbles and Chalcedonies.
Veined Venosus Geadert	When in lines more or less tortuous, as in Marbles.
In Ruins Ruinenförmig	When they resemble a town in ruins, as the Florentine Marble, as it is called.

The External Forms. Figuræ. Die Aeussere Gestalt.

Come under three divisions; the *crystallised* or *regular*, the *particular*, and the *amorphous*.

The Crystallised are those which have a more or less determinate form, composed of sides and angles. Examples, all Crystals.

Particular, those which resemble some

known body. Examples, as the dendritical, botryoidal, dentiform, and globular forms.

AMORPHOUS, those which are destitute of regular shape, and resemblance. Example, any common stone or fragment of a rock.

In the crystallised several things are to be attended to.——Some are uniform, as the tetraedron or solid triangle fig. 1, and the cube fig. 6, in plate 3; and others are composed of two distinct parts, a prism let. a, and pyramids let. b, in fig. 15 and 22; or of two pyramids, as fig. 14, 16, 21.——As polyedral forms they are composed of sides and angles. The angles formed by the incidence of the sides we shall call the *edges*, let. c, fig. 6. Those formed by the incidence of the prism and pyramid or of two pyramids, let. a, fig. 21 and 22, the *angles*; those formed by the junction of three or more planes, let. e, fig. 6 and 14, the *cor-*

ners;

ners; and the junction of the several sides of a pyramid the *points*, let. f, fig. 21 and 22.

Though crystals vary exceedingly, yet are they reducible to a few primary forms, as the multiplicity arises from the absence of their edges, angles, corners, and points; or, as it is conveniently expressed, by the truncation of these parts, and by their increase in some particular directions. When these truncations and partial increase are great, they render a crystal to an unexperienced eye undistinguishable, and the former cut off so much of the crystal as sometimes to take away the original faces, and produce others whose incidence forms angles quite different from the primary. Sometimes likewise the corners, edges, &c. are beveled or sloped off.—Fig. 9 represents the cube fig. 6, with the corners truncated. Fig. 10, the same, more deeply truncated. Fig. 11 represents the cube fig. 6, with the edges truncated.

Fig. 12, both edges and corners truncated. Fig. 13, the edges beveled or ſloped off.

The variations from partial increaſe, or extenſion in a particular direction, are repreſented by the figures 6, 7, 8. The quadrangular table 7, requires only to be thicker, that is, higher, to be like fig. 6; and fig. 6 to be higher, to be the ſame as fig. 8. Thus the cube on the one hand becomes a table; and on the other, a column. The figures 15, 16, 17, are but variations of the primary form 14; as 15 is the ſame as 14, only with an intervening priſm; and 16 is 14 lengthened in one direction; and 17 is 16 with the points of both pyramids truncated and drawn in another poſition. Similar variations are repreſented by the figures 21 to 28. Fig. 21 is the primary or moſt ſimple form of rock cryſtal. Fig. 22 the ſame, with a priſm ſeparating the pyramids. Fig. 23 the ſame, with a long priſm. Fig. 24 with

with only one pyramid. Fig. 25 and 26 are the ſame as 23, but both irregular. And 27 and 28 are the ſame as 22, but very irregular. Yet, notwithſtanding theſe variations and this irregularity, each pyramid is compoſed of ſix ſides, and each priſm of the ſame number; and the angles formed in each cryſtal by the junction of the two pyramids, or of the pyramids and priſms, are the ſame in all; the angles formed by the junction of the two pyramids being 104 degrees, and thoſe of the pyramids and priſm 142. In this manner very complicated ſtructures are traced up, very frequently by the fineſt gradations, to the moſt ſimple, as fig. 20 to a rhomb, nearly ſimilar to fig. 18. Thus order is brought out of confuſion, and the moſt irregular forms reduced into ſyſtematic arrangement.——A regular ſeries of cryſtals or models of them is a very curious and pleaſing ſight.

From hence it will readily appear, that from a few primary forms many others ariſe, and that not the number of ſides, but the angles of incidence formed by the junction of the ſides of the two pyramids, or pyramid and priſm; and in the more ſimple forms of their faces or ſides, are to be principally attended to.

The Primary Forms, according to Mr. Romé de Liſle, are ſix:

The Tetraedron or ſolid triangle,	Fig. 1.	4 Equilat. triang.
The Cube,	Fig. 6.	6 Regul. ſquares.
The Octaedron,	Fig. 14.	8 Equilat. triang.
The Rhomboidal Parallelopiped,	Fig. 18.	6 Rhombs.
The Rhomboidal Octaedron,	Fig. 19.	8 Scalene triang.
The Dodecaedron, with triangular ſides,	Fig. 21.	12 Iſoc. triang.

The

TABLE I.

[To face Page 136.]

No.	Form	Sides	Faces	Examples
	From the TETRAEDRON, fig. 1. —— —— which has	4 sides	4 equilat. triang. —— ——	Examples, Grey and Yellow Copper Ores and Blende.
	we have the			
1	TETRAEDRON with the corners truncated, fig. 3 ——	8	4 equilat. triang. 4 regular hexag. ——	Grey & Yellow Copper Ores & Blende.
2	with the corners bevelled off by the sides ——	16	12 isosc. triang. 4 regular hexag. ——	Grey Copper and Blende.
3	with the corners bevelled off by the angles ——	16	12 trapez. 4 enneag. ——	Grey Copper.
4	with an obtuse triedral pyramid on each side ——	12	12 isosc. triang. ——	Grey and Yellow Copper.
5	the same with points of the four pyramids truncated ——	16	4 equilat. triang. 12 trapez. ——	Grey Copper.
6	the same very deeply truncated —— ——	16	4 equilat. triang. 12 trapez. ——	Grey Copper and Blende.
7	the same with the four primitive corners bevelled off by the sides	28	4 equilat. triang. 12 rectang. quad. 12 rhombs.	Grey Copper and Blende.
8	the same with corners so deeply bevelled off as to take away the angles of the 4 triangular sides —— ——	28	12 rectang. quad. 12 irreg. pentag. 4 hexagon.	Grey Copper.
9	the same as No. 6, with the four corners truncated ——	32	8 equilat. triang. 12 isosc. triang. 12 trapez.	Grey Copper and Blende.
10	the same as No. 8, with the four corners truncated ——	32	4 equilat. triang. 12 rectang. quadrang. 16 hexag.	Grey Copper and Blende.
11	the primary form with its six edges truncated, fig. 4. ——	10	4 equilat. triang. 6 lineal hexag.	Grey and Yellow Copper.
12	the same with its corners truncated and these edges truncated ——	26	4 equilat. triang. 12 rectang. quadrang. 10 hexag.	Grey Copper.
13	the primary form with the edges and corners truncated and again bevelled off by the sides —— ——	38	8 equilat. triang. 12 rectang. quadrang. 12 irreg. pentag. 6 lin. hexag.	Grey Copper.
14	the same as No. 10, with the 6 prim. edges truncated ——	38	4 equilat. triang. 12 rectang. quad. 10 hexag. 12 octag. —— ——	Grey Copper.
15	the same as No. 8, with the 3 edges of the corners retruncated ——	40	12 irreg. pentag. 28 hexag. — ——	Grey Copper.
16	the primary form, with three trapeziums on each side, and the 6 prim. edges bevelled off, with the triangles of the base alternating with those of the sides —— —— ——	24	12 isoc. triang. 12 trapez. — ——	Blende.
17	the same with the four corners of the sides truncated ——	28	4 equilat. triang. 12 isosc. triang. 12 irreg. pentag.	Blende.
18	the same more deeply truncated —— —— ——	28	4 equilat. triang. 24 isosc. triang.	Blende.
19	the same as No. 17, with the 6 solid edges truncated ——	34	4 equilat. triang. 12 isoc. triang. 6 lineal hexag. 12 irreg. heptag. — ——	Blende.
20	two obtuse Tetraedrons joined base to base —— ——	6	6 isosc. triang. — ——	The Diamond.
21	the same with both pyramids truncated near their bases ——	8	2 equilat. triang. 6 trapez. ——	The Diamond.
22	two regular Tetraedrons joined base to base truncated near their bases	8	2 equilat. triang. 6 trapez.	Cinnabar.
23	the same, with an intervening triangular prism ——	11	2 equilat. triang. 3 rectang. quadrang. 6 trapez.	Cinnabar.

In the ſame manner do the other four Primary forms afford not leſs numerous varieties *.

Sometimes cryſtals have, beſides their ordinary angles, one or more angles inwards,

* To make the Catalogue of external characters complete, I ought, in my own opinion, to have gone through the variations of the other primary forms; but having written this work in the country, I could not conſult the *Cryſtalographie* of Mr. Romé de Liſle till this was already in the Preſs; and then the want of time prevented me. However, I expect rather to be thanked than cenſured, for this omiſſion. Our firſt authority in mineralogy has given his opinion against the utility of the ſtudy of cryſtals; and this according with our natural diſlike to nice diſcriminations, the fruits only of cloſe application, I am afraid nothing I can ſay againſt this opinion will be attended to. Yet this I ſhall ſay, that from the cryſtallization alone we may know many foſſils at firſt ſight, and by induction aſcertain the nature of the rocks or matrix in which they are; and that, were mineral bodies more frequently cryſtalliſed, their forms could no more be neglected than thoſe of organic bodies.———Should this work be reprinted, I ſhall venture to add what I have omitted—but trace ſome of the variations from leſs diſtant forms, by increaſing the number of the primary forms.

as

as if pieces had been cut out, as in fig. 29. This is the consequence of two cryſtals, or two half cryſtals, uniting by the ſame ſides, or by their growing in and croſſing one another. The French call them *macles*, the Germans *zwillings*, or twin cryſtals. Fig. 29 repreſents a macle of gypſum, formed by the junction of two ſimilar ſides of the primitive rhomboidal decaedron. Fig. 30 repreſents a macle of the *Pierre de Croix*——formed by the croſſing of two hexagonal priſms.

Sometimes minerals form themſelves as incruſtations upon cryſtals, or fill cavities they have left, and thus aſſume their ſhape; theſe in general are eaſily diſtinguiſhed from true cryſtals, and are called *After* or *Speudo Cryſtals* by the Germans.

THE PARTICULAR FORMS ARE, THE

Globular Globularis Kuglicht	Spherical. Example, the Pisolithus.
Oval Ovalis	Elliptical.
Ovate Ovatus Elliptische	Like an Egg, broader at one end.
Cheese-shaped Käseförmig	A very compressed Sphere. Example, Egyptian Jasper, as it is called.
Almond-shaped Amygdalinus Mandelförmig	Like an Almond. Examples, the Concretions in the Amygdaloid Rocks.
Lenticular Lentiformis Linsenförmig	Like a Lens, comprest, and gradually thinner from the middle towards the edges.
Cuneiform Cuneiformis Keilförmig	Like a Wedge.
Nodulous or Tuberous Tuberosus Knollig	Having depressions and protuberances like a Potatoe. Example, Flints.
Botryoidal Botryoides Traubig	Like Grapes closely prest together. Examples, Malachite and Manganese.
Mammillary Mammillaris Nierenförmig	This differs from the preceding that the Protuberances are smaller Segments of larger Spheres. Examples, Malachite and Hematites.
Dentiform Dentiformis Zähnig	With Mr. Werner, is the form in which Metallic or Native Silver is often found, when it is longish and tortuous, and thicker at the bottom than the top, where it ends in a point.
Wireform or Filiform Filiformis Dratförmig	Like Wire. Examples, Native Gold and Silver. Differs from the following only by being thicker.

Capillary Capillaris Haarförmig	Like Hair. Differs from the preceding only by being thinner. Examples, Gold and Silver.
Confused Confusus	This is applied chiefly to the two preceding kinds, when the fibres are so confusedly interwoven as not to be followed by the eye, nor admit of a definition. Examples, Native Silver and Copper.
Retiform or Netted Retiformis Gestrickt	Is when the fibres or strings are so crossed and connected as to imitate net work. Examples, Native Gold, Silver and Copper.
Dendritic Arborescens Baumförmig	Like a Tree, having branches and subdivisions from a common stem. Examples, Native Gold and Silver, Manganese, &c.
Shrubby Fruticosus Staudenförmig	Like a Shrub, the branches rising from the ground without a common stem. Example, Native Silver.
Coralloidal Ramosus Zackig	When branched like Coral. Example, Flos Ferri.
Stalactitical Stillatitius Tropfsteinartig	Like Icicles. Examples, Calcedony, Hematites and Calcareous Stalactites.
Clavated Clavatus Kolbenförmig	Like a Club, long, and thicker at one end. Example, in Black Hematites.
Fasciform Fasciformis Röhrenförmig	Long straight cylindrical bodies, united, and looking like a bundle of Reeds or Sticks. Examples, in Hematites.
Tubular Tubulosus	Nearly cylindrical, and hollow.

THE EXCAVATED OR IMPRESSED FORMS.

Cellular Cellulosus Zellenförmig	This form, according to the Wernerian School, arises from Plates and Lamellæ standing on their edges and crossing one another in different directions,

	tions, the vacuities between the plates being the cells, which are to be described according to their shape, as *quadrangular*, &c. But when the plates are curved, the cells lose their angular shape, and form the *round-cellular*, the *spongiform cellular*, the *indeterminate cellular*, the *double cellular*, and the *veiny cellular*.
With Impressions Foveolatus Mit Eindrücken	Having hollows which have been formed by various objects, as Crystals, which had been imbedded here, but have fallen out or been destroyed. They are to be described according to their shapes.
Perforated Perforatus Durchlöchert	Having many deep roundish holes. Example, Bog Iron Ore.
Corroded Erosus Zerfressen	Differs from the preceding in having the holes much smaller and closer together. Example, in Galena and Vitreous Copper Ores, and Native Arsenic.
Vesicular Vesiculosus Blasig	When the Cells are so close together as to be only separated by a thin partition. Examples, in Lava and Pumex.
Heteromorphous Heteromorphus Ungestaltet	Having various protuberances, indentations and hollows. Examples, Vitreous Copper Ore, Native Arsenic, and Bog Iron Ore.

The Amorphous.

Amorphous Amorphus Derb *	Without any particular form, from the size of a grain of wheat to the greatest bulk. Example, most Minerals.

* This term has frequently been misunderstood. The best explanation of it is this; that it is negative, and expresses only that the body to which it is applied has nothing in its form to be attended to.

Inſperſed Inſperſus Eingeſprengt	When in ſmall parts not exceeding the ſize of a pea, and without any particular ſhape, imbedded in ſome other Foſſil. Example, Vitreous Copper Ore in Quartz.
In fragments Fragmentis In Eckigten Stücken	When in angular fragments, and not ſmaller than a ſmall nut, and looſe or unconnected. To be deſcribed whether with *ſharp or blunt* angles. Examples, Quartz, &c.
In Grains Granulis In Körnern	When of no particular ſhape, but roundiſh, and not exceeding the ſize of a ſmall nut to the ſmalleſt viſible ſize, either looſe or imbedded. Examples, Garnets in Serpentine, and Platina.
Specular Specularis Spiegelicht	Having a poliſhed ſurface, reflecting in ſome meaſure like a mirror. It is almoſt peculiar to the Ores of Metals, as Galena, Pyrites, Cobalt, &c. It rather belongs to the characters of Surface than Form.
In Plates Laminis In Platten	When in flat, broad, even pieces, much broader and longer than thick. Example, Native Silver.
Foliaceous or In Leaves. Foliis In Blättchen	When in thin leaves either ſtraight or crooked. Native Gold, Silver, and Copper are often in this form.
Superficial Superficialis Angeflogen	When one Mineral thinly covers another. Examples, Native Gold and Silver, Red Silver Ore, &c.

The forms of Extraneous Foſſils, thoſe belonging to the animal and vegetable kingdoms, I omit, though introduced by the ableſt diſciples of Mr. Werner, as Mr. Wiedenman

and

and the Abbé Eſtner. When theſe extraneous bodies are mentioned, they ſhould be merely named, if already known ; if not, deſcribed ſcientifically according to the principles of the Linnean School.

The Exterior Surface. Superficies. Die Oberflache.

Uneven Inæqualis Uneben	When compoſed of very ſmall unequal elevations and depreſſions. Example, Calcedony.
Scabrous Scabroſa Schrof	When with very ſmall, ſharp and rough elevations, often more eaſily felt than ſeen. Chiefly obſerved on Cryſtals, as the Brazilian Diamond, and on the Hematites. It paſſes intothe following.
Druſy Druſig	When it is compoſed of very minute Cryſtals. This kind runs into the preceding. Examples, Galena, Fluor, Pyrites.
Rough Aſpera Rauh	When it is compoſed of very minute, almoſt imperceptible, pointed or obtuſe elevations, moſt diſtinguiſhable by the feel. Examples, in Stalagmites, Sandſtone, &c.
Scaly Squamoſa Schuppig	When compoſed of very minute thin Scale-like Leaves. Examples, in Calcareous Spar, and but few more.
Smooth Levis Glatt	When free from all roughneſs and inequalities. Examples, in Cryſtalliſed Fluors, Barytes, and Calcareous Spar, &c.

Specular

Specular
Specularis
Spiegelicht

Having a ſmooth poliſhed ſurface like a Mirror; peculiar almoſt to the Ores, as the Galena, Pyrites, Cobalt, &c.

Streaked
Striata
Geſtreift

With elevated, ſtraight and parallel lines. Examples, chiefly in Cryſtals. There is the TRANSVERSELY ſtreaked, as Quartz-cryſtals; the LONGITUDINALLY ſtreaked, as the Schorl; the DIAGONALLY ſtreaked, as the Specular Iron Ore; the ALTERNATELY ſtreaked, as the Cubic Pyrites, where the lines on different ſides of the Cubes run in different directions; the PLUMOUS ſtreaked, where the lines run from a middle line or rib, as in Native Silver and Biſmuth; the DECUSSATEDLY ſtreaked, as in the White Cobalt Ore, where the lines croſs one another.

The Lustre, Nitor. Der Glanz.

Splendent
Splendens
Starkglängend

This is the greateſt degree, and may be ſeen at a diſtance, as Mica and Galena.

Shining
Nitens
Glänzend

Leſs than the preceding, as in Shorl, Quartz, Heavy Spar, Calcareous Spar, Native Gold and Silver, and Platina.

Dulliſh
Sub-lucens
Wenig-glängend

Leſs than the preceding, as the Fibrous Gypſum, the Jade.

Dull
Obſcurus
Matt

Is when only parts ſhine, as in the Potſtone or Lapis Ollaris, and Limeſtone.

Glimmering
Micans
Schimmernd

Without any Luſtre, as Chalk, Malachite, Iron-Stone, Calamine, and Petroſilex.

Independent

Independent of the foregoing, which differ in degree, there are the following, which differ in their kinds, whose degrees may be expressed by the preceding terms :

Common Lustre Nitor Vulgaris Gemeine Glanz	This is common to most Stones and Crystals, as Quartz, Shorl, Feld Spar, Calcareous Spar, &c. which, though differing in degree, have the same kind of Lustre.
Mother of Pearl L. Nitor Margaritaceus Perl-mutterglanz	Like Mother of Pearl. Examples, in Zeolite, and Schiefer Spar.
Silky Lustre Sericeus Seidenglanz	Like Silk. This and the preceding are much alike. Examples, Amianthus, Fibrous Gypsum, Fibrous Malachite, and Pumex.
Waxy Lustre Nitor Cereus Wachs-glanz	Like Wax. Examples, the Semi Opal, and the Yellow Lead Ore.
Diamond Lustre Nitor Adamantinus Diamant-glanz	Like the Lustre of the Diamond. Examples, the Diamond, the Jargon, and the White Lead Spar.
Greasy Lustre Nitor Pinguis Fett-glanz	As if greased. Examples, Jade, Talc and Steatite.
Metallic Lustre Nitor Metallicus Metall-glanz	That which is common to most Metals; besides which, this kind of Lustre is found in the White and Brownish Mica, and Brown Iron Glimmer (Eisen Rahm).

When the external Lustre differs from the internal, it is generally accidental, arising frequently from decomposition and mere superficial mineral depositions, &c. The internal Lustre should therefore be chiefly attended to as least variable, and consequently most characteristic; but the same terms may be used when speaking of the external Lustre.

The Texture. Textura.

Is the internal ſtructure or diſpoſition of the matter of which a Mineral is compoſed *.

Compact Compacta Dicht	Without any diſtinguiſhable parts, or the appearance of being compoſed of ſmaller parts. Examples, Chalcedony, Flint, &c.
Earthy Terrea Erdig	When compoſed of very minute, almoſt inviſible, rough parts, as Clay, Marle, &c.
Granular Granulata Körnig	When compoſed of ſmall ſhapeleſs Grains, as Granulated Quartz, Sand Stone, &c.
Globuliform Globuliformis	When compoſed of ſmall Spherical Bodies, as the Piſolithus and Oolithus.
Fibrous Fibroſa Faſerig	When compoſed of Fibres. Examples, Fibrous Gypſum and Amianthus. The Fibres may be

* Mr. Werner ſays nothing on the Texture of Minerals, but under the Article of Fracture, gives many characters which belong not to the Fracture but to the Texture, ſo that the characters of Texture and Fracture, though very different, are united under one head and confounded together. But in the works of Meſſrs. Wiedenman and Eſtner, there is an Article on the *Geſtalt der Ausgezeichneten*, or, *Abgeſonderten Stücke der Bruchflache*, under which ſeveral characters of the Texture are given. Some of theſe I have arranged under this article, others under that of *Structure* or Compound Texture. In Mr. Werner's own work on the Outward Characters, this article on the *Ausgezeichneten*, &c. does not exiſt.

Fine

Fine	Tenuibus	Zart, or
Coarſe	Craſſis	Grob.
Long	Longis	Lang, or
Short	Brevibus	Kurz.
Straight	Rectis	Gerade, or
Crooked	Curvatis	Krumm.
Parallel	Parallelis	Gleich laufend.
Divergent	Divergentibus	Aus einander laufend.
Stellated	Stellatis	Sternförmig.
Faſciculated	Faſciculatis	Büſchelförmig, or
Decuſſated	Decuſſatis	Unter einander laufend.

Radiated
Radiata
Strahlig

When compoſed of long, narrow, flattiſh Lamellæ. This differs from the Fibrous by the parts being broader. Examples, Grey Antimony, Manganeſe, Zeolite, Actynolite, &c. This admits of the ſame variations as the preceding.

Lamellar
Lamelloſa
Blättrig

When compoſed of ſmooth continued leaves or plates, covering one another. Example, as the Spars. They may be

Straight	Rectis	Gerade	As in moſt Spars, or
Crooked	Curvatis	Krumm	As in Schiefer Spar, or
Spherical	Sphæricis	Sphäriſh	As the Mica Hemiſphærica.
Undulating	Undulatis	Wellenförmig	As in Talc.

And in regard to their direction, may be

Uniform	Simpliciter	Einfach	All lying one way, as in Selenite.

Double	Dupliciter	Zweifach	Lying in two directions, as in Feldspar and Hornblende.
Triple	Tripliciter	Dreyfach	Lying in three directions, as in Calcareous Spar.
Quadruple	Quadrupliciter	Vierfach	Lying in four directions, as in Fluor Spars.
Sextuple	Sextupliciter	Sechsfach	Lying in six directions, as some Blendes.

This Texture is peculiar to more or less Crystallised Minerals.

Slaty Schistosa Schieferig	Composed of thin layers or beds, as Slates. As the preceding was more peculiar to the Crystallised, so is this to the Rupestrious Fossils. As this is rather a character of *Structure* than Texture, probably it might be omitted here.
Scaly Squamosa Schuppig	Composed of a congeries of small Scales. Peculiar to the Plumbago, according to l'Abbé Estner.
Sparry Spathosa	Composed of a congeries of irregular Crystalline Parts, like Coarse Salt, as the coarser kinds of Scaly or Saline Limestone, as that of Sala in Sweden, some Hornblende-Schistus. This belongs to the Granulated of the Wernerian School.

In judging of the texture, attention must be paid, when it is not of the compact kind, but of the fibrous or lamellar, that it is inspected in a proper direction, which is that of its parts; otherwise, when in the opposite direction, the fibrous may appear granulated, and the lamellar radiated.

The

The STRUCTURE or COMPOUND TEXTURE.
STRUCTURA. TEXTURA COMPOSITA.
GESTALT der ABGESONDERTEN STÜCKE.

Is the particular diſpoſition of the preceding Texture. Thus the Argillaceous Schiſtus has the Earthy Texture and the Schiſtous Structure; ſome Hornblende Schiſtus, the Sparry Texture and the Schiſtous Structure. The Argillaceous Iron Ore of Hoſchennitz, the Earthy Texture and the Columnar Structure. The Hematites and Malachite, the Fibrous Texture and the Teſtaceous Structure; and Native Arſenic, the Earthy Texture? and the Teſtaceous Structure.

Slaty Schiſtoſa Schieferig	When in thin ſtraight layers, as Slate.
Teſtaceous Teſtacea Schaalicht	When in more or leſs curved or undulating layers, as Native Arſenic and Hematites; and Stalagmites or Calcareous Depoſitions.
Concentric Concentrica	When in concentric layers, as Agate Balls, and the Globules of the Piſolithus.
Columnar Columnaris Stänglich	When in columns or priſms, as the Iron Ore of Hoſchennitz.

Theſe internal ſurfaces formed by a diviſion in the line of the compound texture may be deſcribed in the ſame manner as the exterior ſurface, both with reſpect to Smoothneſs and Luſtre.

The FRACTURE. FRACTURA. Der BRUCH.

Is the fresh Surface of a Mineral when broken.

Flat Plana Flach	When without any general elevation or depression. Examples, Common Limestone, and most Rock or Rupestrious Stones. This term is opposed to the Conchoidal.
Conchoidal * Conchoidea Muschelig	Having wide extended roundish hollows and gentle risings and swellings. Examples, in Flint, Quartz Crystal, Obsidian, and Opal.

When the hollows and risings are not very evident, it is called the *Flat-concboidal, Plano-concboidea, Flat-muschlig*; when small in extent, *Small-concboidal*; when great, *Great-concboidal*.

Even Æqualis Eben	Free from all asperities and small elevations. Example, Chalcedony.
Uneven Inæqualis Uneben	Having many small, sharp, abrupt, irregular elevations and inequalities. Examples, Grey Copper Ore, Common Pyrites, sometimes the Arsenical Pyrites, and Tin Ores. According to the size of the inequalities, there is the *coarse*, *small*, and *fine uneven*.

* It seems the Wernerian School consider this character as incompatible with the Splintery; and therefore, when they occur in the same specimen, they say they pass into one another. I think some of the characters of fracture are not excluded by some others. Thus the conchoidal fracture may be splintery, as in some kinds of Petrosilex.

Splintery

Splintery Festucaria Splitterig	Having ſmall thin half detached ſharp-edged Splinters, which being large or ſmall, form the *Coarſe* or *Fine* Splintery.
Rugged Scabra Hakig	Having many very minute ſharp hooks, more ſenſible to the hand than the eye. This is peculiar to the tough Malleable Metals.

The Shape of the FRAGMENTS. FRAGMENTA. BRUCHSTÜCKE.

The pieces into which a Mineral breaks are various in ſhape, according to the particular kinds; as the

Cubic Cubica Würflichte	As the Fragments of Rock Salt and Galena.
Rhomboidal Rhomboidea Rautenförmige	As of Calcareous Spar.
Pyramidal Pyramidalia Pyramidaliſche	As of Fluor Spar.
Wedge-ſhaped Cuneata Keilförmige	As of Zeolite and Hematites.
Splintry Feſtucaria Splitterige	Thin, long, and pointed, as of Aſbeſtos, Fibrous Hematites, and ſome Antimonial Ores.
Tabular Diſcoidea Scheibenförmige	Thin and broad, and ſharp at the corners, as of Slate.

Indeterminate Indeterminata Unbestimente	Without any particular resemblance, as of most Minerals, Quartz, Petrosilex, Flint, Lime-stone, &c. To be described according to the sharpness of the angles and edges, *very sharp, sharp, sharpish, blunt*.

The TRANSPARENCY. PELLUCIDITAS. Die DURCHSICHTIGKEIT.

Pellucid Pellucidus Durchsichtig	This is the greatest degree of transparency, when objects are seen distinctly as through glass. Examples, Quartz Crystals, Selenite, and some Calcareous Spars.
Diaphanous Diaphanus Halbdurchsichtig	When objects are seen but indistinctly, as through Chalcedony.
Subdiaphanous Subdiaphanus Durchscheinend	When light passes through, but so little, that objects cannot at all be distinguished. Examples, Chrysoprase, Prase.
Angles Subdiaphanous Angulis Subdiaphanis An den Kanten Durchscheinend	When subdiaphanous only on the thin corners and edges. Examples, Petrosilex, Flints and some Marbles.
Opake Opacus Undurchsichtig	When in no wise transparent, as Jasper, Indurated Clay, and the Metals.
Doubling Duplicans Verdoppelnd Durchsichtig	Doubling the objects seen through them, as Calcareous Spar in thick pieces.
Hydrophanous Hydrophanus	Opake, but becoming transparent when wetted like the Hydrophanus.

The

The Scratch. Scriptura. Der Strich.

Is the mark left when a mineral is rubbed or scratched with any hard sharp body, as the point of a knife; which is

Similar Concolor Gleich-farbig	When the same as the body itself, as the Ardesia Nigrica, and the Red Hematites or Blood Stone.
Dissimilar Discolor Verschieden	When different, as most dark-coloured Slates, which generally give a Whitish powder. The colours then are to be described, which are generally lighter than the body itself. Thus Black Blende gives a Reddish Brown colour.

The Score. Tractus. Der Strich.

This Character is only applicable to a few Minerals of a soft, toughish, or earthy nature, which being pressed or scored with the nail or other hard body, receive a polished or shining streak, as Boles and Clays, Horn-Silver, the Black-Silver and Black Cobalt Ores.

The Soiling. Inquinatio. Das Abfärben.

Is the property some few Minerals possess of soiling the fingers, or any other object, on the lightest touch, as Red Chalk, Hematites, Black Manganese Ore, and Red Iron Glimmer, likewise common Chalk.

Soiling Inquinans Abfärbend	When they soil.

Clean

Clean
Tersum
Nicht-abfärbend — When they do not soil.

The Cohesion. Cohesio. Die Härte, Geschmeidigkeit, Zusammenhang, und Biegsamkeit.

Under this head I include the different Degrees of Hardness, Ductility and Elasticity.

Very Hard Durissimus	Not to be scratched or worn by the best File, as the Diamond, Jargon, and the Ruby.
Hard Durus	Which are but just affected by it, as the Topaz, Beryl, Quartz-crystal, Chalcedony, &c.
Hardish Subdurus	So hard as to strike Fire with the Steel, but may likewise be scratched with the point of a Knife, as Feldspar.
Softish Rasilis	Not striking Fire with Steel, yet only just to be scraped with the Knife, as Limestone.
Soft Mollis	Not to be scratched with the Nail, yet very easily scraped with the Knife, as Heavy Spar and Serpentine.
Very Soft Mollissimus	To be scratched with the Nail, as Talc, Gypsum, Horn-silver, &c.
Brittle Fragilis Spröde	Not bearing to be cut, but either resisting or breaking into pieces under the Knife, and flying in pieces under the stroke of a Hammer, as Grey Copper Ore, Calcareous Spar, Heavy Spar, &c.

For the different Degrees see the next page.

Sectile

Sectile Sectilis Milde	That may be cut without breaking, but is not Malleable, as the Vitreous Copper Ore, Antimonial Silver Ore, &c.
Ductile Ductilis Geschmeidig	That may not only be cut without breaking, but is more or less Malleable, as Metallic or Native Gold, Silver, and Copper, likewise Vitreous Silver Ore.
Flexile Flexilis Gemeinbiegsam	Which bends without breaking and continues bent, as the Mountain-Cork.
Elastic Resiliens Elastisch biegsam	Which bends, but recovers its former direction on the force being discontinued, as the Elastic Sand-stone from Brazil, and the Elastic Bitumen from Derbyshire.

To these Characters are added by the Disciples of Mr. Werner, the following Degrees of Fragility under the stroke of the Hammer.

Very Tough Tenacissimus Sehr-schwer-zerspringbar	As many Basalts and Schistous Porphyry.
Tough Tenax Schwer-zerspringbar	As Petrosilex.
Fragile Fragilis Leicht-zerspringbar	As Rock Crystal, Scaly Limestone, &c.
Very Fragile Fragilissimus Sehr-leicht-zerspringbar	As Grey Copper Ore, Calcareous Spar, Heavy Spar, &c.

The

The Adhesion to the Tongue. Linguæ Adhærentia. Das Anhängen an den Lippen.

This Character is met with in only a few Minerals, as the Hydrophanus, Lithomarga, &c. and ariſes from their ſucking in the Humidity of the Tongue or Lips; and in regard to this Property there are three Diſtinctions, (with ſome Five) as *Strongly*, *Feebly*, and *Not adhering*.

The Sound. Sonus. Der Klang.

Is different in a few Minerals, ſome few on being ſtruck giving a

Clear Sound Clarus Klingend	As Slates. Others a
Dull Sound Surdus Dumpf	As moſt Minerals. A
Grating or Craſhing Sound Fragoſus Geräuſche	Is heard on gently breaking of Pumex; a
Screaking Stridoſus Knirrende	On the bending of Tin.

The Feel. Tactus. Die Fettigkeit beym Anfühlen.

Of Minerals, is the Senſation their ſmooth Surfaces produce on being handled; for ſome, though without any thing oily in their Compoſition, have a greaſy feel. Some are,

Very

Very Greafy Pinguiffimus Sehr-fett	As the fine Iron Glimmer and Black Lead.
Greafy Pinguis Fett	As Common Talc, Steatites, and the Jade.
Rather Greafy Sub-pinguis Wenig-fett	As fome Slates and the Whetftone.
Dry Macra Mager	As Chalk, Limeftone, Jafper, Bafalt, and moft Foffils that have not much Magnefia in their compofition.

COLDNESS. FRIGIDITAS. Die KÄLTE.

The Characters under this Head are formed from the Senfation of Cold that we feel when a body which is a good conductor of heat is applied to the fkin. They are of little ufe, being dependent on other properties, which we know by as eafy means and more accurately.

THE DEGREES ARE,

Very Cold Frigidiffimus Kalt	As the Diamond, Quartz, Chalcedony, Flint, and Marble.
Cold Frigidus Ziemlich kalt	Schiftus, Serpentine and Gypfum.
Coldifh Frigidiufculus Wenig-kalt	Chalk, Coal, &c.

The DENSITY. GRAVITAS. Die SCHWERE.

Is only to be afcertained with accuracy by the means of Hydroftatic Balances. But there are fuch confiderable differences in regard

regard to weight in different Minerals, that ſeveral degrees are diſtinguiſhable merely by the hand, as

Very Light or Swimming Natans Schwimmend	Being lighter than Water, as Petroleum, Mountain-Cork, Pumex, and Lac Lunæ.
Light Levis Leicht	When not above twice as heavy as Water, as Coal, Sulphur, and Amber.
Rather Heavy Subponderoſus Nicht-beſonders-ſchwer	When from two to four times as heavy as Water, as Rock-Cryſtal, Chalcedony, Flint, Limeſtone, and moſt Stones.
Heavy Ponderoſus Schwer	When from four to ſix times as heavy, as the Heavy Spar, Iron-ſtone, Spathous Iron Ore, Blende, Hematites, &c.
Very-heavy Ponderoſiſſimus Auſſerordentlich-ſchwer	When above ſix times as heavy, as all the Metals in the Metallic State, and Galena, Cinnabar, Wolfram, &c.

The Smell. Odor. Der Geruch.

Of Minerals, affords us but few characters, as they are moſtly inodorous. However, there are the following:

Bituminous Bituminoſus Harzichte	As Petroleum and Maltha.
Sulphurous Sulphureus Schwefelichte	Sulphur and Common Pyrites.
Argillaceous Argillaceus Thonichte	As when Traps, ſoft Argillaceous Stones and Argillaceous Limeſtone are breathed on.

Urinous

Urinous Urinofus Urinofe	As that of the Swine Stone or Suillus when rubbed.
Hepatic Hepar Sulphuris Hepatifche	As that of a kind of Cinnabar from Idria when rubbed.
Arfenical Arfenicalis Knoblauchartige	Or like Garlic, as Arfenical Pyrites, or other combinations of Arfenic, when ftruck with the fteel or hammer.
Singed Uftulatus Brandichte	As Quartz and other Siliceous Stones when ftruck or rubbed together.

The Taste. Sapor. Der Geschmack.

This is peculiar to the Salts; other Minerals being almoft or quite infipid.

Salt Salinus Gemeinfalzig	As Common Salt.
Sweet-aftringent Dulce-adftringens Süfszufammen-ziehende	As Alum.
Styptic Stypticus Herbe	As Vitriol.
Bitter-falt Salino-amarus Salzig-bitter	As Vitriolated Magnefia.
Acrid-falt Acre-falinus Salzig-brennende	As Sal Ammoniac.

Cool

Cool-Salt Frigide-salinus Salzig-kühlende	As Saltpetre.
Alkaline Lixiviosus Laugenhafte	As Mineral Alkali.

The preceding Characters concerned the Firm and Solid Minerals. We have to observe the following Characters in the

FRIABLE. FRIABILIA. ZERREIBLICHE.

And such Mineral Bodies are thus called which have so little Cohesion, as to be crushed between the Fingers, or are in a state of minute Division, as Sand or Powder. The Friable Minerals are destitute of many of the principal Characters, as Form, Hardness, Fracture, &c. &c. which serve to distinguish those that are Solid, and are therefore very often difficultly known without the additional aid of chemical tests. In regard to the form and fineness of the parts, they are,

Impalpable Impalpabilis	With parts neither visible, nor sensible to the touch, as the Lac Lunæ, Porcelain Clay, &c.
Pulverulent Pulverulenta	Invisible, but sensible to the touch.
Granular Granularia	With roundish visible parts, as Sand.
Squamous Squamosa	With very minute flattish parts, as the Earthy Talc, and Red Iron Glimmer.

In

In regard to LUSTRE. NITOR. GLANZ.

The Friable never equal the Solid Minerals, there is only the

Dull Obſcurus Matt	As Chalk; and the
Glimmering Micans Schimmernd	As ſome kinds of Sand, which may be either of the
Common Communis Gemeine	As the Earthy Talc; or of the
Metallic Metallicus Metal Glanz	As the fine Iron Glimmer.

The SOILING of the Fingers, and the Degrees are to be attended to.

The COHESION.

Is of only two Kinds; the

Cohærent Cohærens Zuſammengebacken	Connected ſo as to be taken up together, as Chalk.
Looſe Non-cohærens Loſe	In unconnected parts; in the ſtate of Powder and Sand.

In FLUID MINERALS. FLUIDA. FLÜSSIGE.

There are but few external Characters. In regard to this general Character they are,

Fluid Fluidus Flüſig	Flowing like Water, as Mercury and Naphtha, or

Thick Spiſſus Zähe	Flowing like Treacle, as Tar and Petroleum.

Their LUSTRE is

Greaſy Pinguis Fettglanz	As in Petroleum.
Metallic Metallicus Metal Glanz	As in Quick Silver.

In regard to TRANSPARENCY, they are

Pellucid Pellucidus Durchſichtig	As Naphtha.
Subdiaphanous Subdiaphanus Trübe	As Petroleum.
Opaque Opacus Undurchſichtig	As Quick Silver.

The preceding characters are all that Mr. Werner conſiders as external; and, ſo far as we can judge by his work on this ſubject, the only characters he uſes: nor do I find in the works of Mr. Wiedenman and the Abbé Eſtner, which are late productions of the ſame ſchool, any others.

The

The only objection to chemical and physical characters is the difficulty of employing them. Not only considerable knowledge in chemistry and physics is required, but tedious processes and accurate instruments. Yet, if there are internal characters easily known, though strictly speaking they should belong to chemistry and physics, I see no reason why we should not employ them. I therefore subjoin the following characters, some of which are certainly as easily applied as many that are considered as external, and as indicative of the essential nature of the minerals in which they are found.

Effervescing Effervescens	When on being touched with Aqua-fortis minute bubbles arise.
Strongly Effervescing Valde Effervescens	When the bubbles rise rapidly, as Lime Stones, Calcareous Spar, &c.
Slowly Effervescing Lente Effervescens	When slowly, as some Clays, some Slates.
Not Effervescing Non Effervescens Fixum of Lin.	As Quartz, Flint, &c.

Bibulous Bibulus	Sucking or abſorbing water when wetted, as Dried Clays.
Intumeſcent in Water Intumeſcens Aqua	Swelling on being wetted, as Fuller's Earth.
Plaſtic laſticus	Soft and tenacious on being wetted, as Clay.
Fatiſcent Fatiſcens	Decompoſing on expoſure to the air.
Volatile Volatilis	Evaporating and diſappearing through heat.
Inflammable Inflammabilis	Burning with flame when heated.
Crackling Crepitans	Flying with a crackling noiſe when heated, as Salt, Calcareous Spar, &c.
Hardening in the Fire Indureſcens Igne	As Clay.
Intumeſcent in the Fire Intumeſcens Igne	As Borax, Zeolite.
Magnetic Magneticus	Which attracts Iron, as the Magnet.
Retractory Retractorius	Which is attracted by the Magnet, as Iron.
Intractable Intractabilis	Not attracted by the Magnet.
Electric Electricus	Attracting light bodies when rubbed, as Amber.
Analectric Analectricus	Not attracting, though rubbed, as Metals.
Pyrelectric Pyrelectricus	Attracting when heated, as the Tourmalin.

Phoſ-

Phosphorescent by Rubbing Phosphorescens Attritu	As some Blendes and Lithomarga.
Phosphorescent by Heat Phosphorescens Calore	As Chalk and Limestone, when rubbed on a Hot Iron.

The following terms will prevent much circumlocution and repeated definitions in the describing of Minerals, and particularly in geological descriptions and reasonings.

A Nucleus Nucleus	Is a central Kernel inclosed within another Body.
The Ground Basis	Of a Stone is the Basis or principal Mass in which Crystals or Fragments of Stone are imbedded, as the Ground of Porphyry.
The Concretions Concretiones	Are the Crystals or Fragments imbedded in a Ground, as the Feldspar of Porphyry.
The Cement Gluten	Is the matter that agglutinates the Concretions, as in the Breccia Rocks. A *Cement* differs from a *Ground* only by being in much smaller quantity.
The Simple Rocks Petræ	Are formed of one homogeneous mass, as Limestone, Petrosilex, &c.
The Compound Rocks Saxa	Are composed of visibly different materials, as Granit, Porphyry, and Breccia.

Rupeſtrious Foſſils (Gebirgeſarten) — Are thoſe that form entire Rocks, and Strata.

Venigenous Foſſils Venigena — Are thoſe that are found in Veins.

A Stratum Stratum — Is a Bed of Rock that is greatly extended, and pretty uniform in thickneſs. Its *Dip* and *Courſe* are to be deſcribed. The *Dip* ſhould be expreſſed by the Angles it forms with the Horizon and the point of the Compaſs towards which it declines. The *Courſe* is always in the croſs direction of the *Dip*. When the edge of a Stratum comes out to the ſurface of the ſoil, or is viſible, it is ſaid to *baſſet* or *crop out*. They are ſometimes bent, and form a convex ſurface: this is called in German a *Buckel* or *Hump*. When with a concave ſurface it is called a *Mulden*. When a Stratum is bent or broken, and forms a *Ridge*, it is called a *Saddle*.

Veins Venæ — Muſt never run parallel with the Strata, but acroſs them. If they run parallel, they are then not Veins, though they ſhould contain Ores, but *Beds*. The Rock which lies on each ſide of the Vein is called the *Side-Rock*. The ſide which lies higheſt is called the *Roof* or *Top*: the loweſt, the *Floor* or *Bottom*. The thin coating of clay which often lies between the Vein and the Rock is called the *Caſe*; and that part of the Vein next to the Side-Rock is called the *Salband* by the Germans. The *Dip* and *Courſe* of a Vein are to be attended to in the ſame manner as thoſe of the Strata.

Mountains
Montes

When running to a great extent in one direction are called *Chains* and *Ridges*; when in heaps, *Clusters*. A Mountain may be *Conical*, having a circular Base, and tapering upwards, or in a *Ridge*. Their Tops are sometimes hollowed out like an inverted Cone, or *Flat*; and sometimes in *Peaks* and *Needles*.

CHAPTER X.

On Claſſification, Deſcription, and Inveſtigation.

I BEGAN this work with an account of the laws by which the foſſil kingdom is governed; I then enumerated the materials of which it is compoſed, and ſhowed the manner in which they are placed; and, laſtly, gave the characters by which theſe bodies are known. I ſhall now make a few obſervations on their claſſification, deſcription, and inveſtigation.

It will appear evident to every one, that in proportion as objects inſenſibly run into each other, the more difficult it muſt be to form characters to expreſs thoſe general properties which are to form them into diviſions, and thoſe peculiar ones which are to diſtinguiſh the different ſpecies and individuals.

duals. Yet it muſt be evident that the difficulty of diſtinguiſhing and charaćteriſing them can only concern congenerous bodies; that there can be no danger of confounding bodies that are widely different, if the characters are well drawn; and that the doubt, if there be any, can only exiſt amongſt a very few ſimilar bodies. So that ſyſtematic arrangement, which always ſuppoſes a ſimilarity in general, and a diſſimilarity in particular characters, is as attainable in the mineral kingdom, as in the animal and vegetable, ſo long as we keep to one kind of characters, though the line of diſtinction often cannot be marked with equal certainty.

The principal difficulty attending the ſelection of the characteriſtics for ſyſtematic arrangements in our preſent ſtudy, is, that theſe ſyſtems are founded upon two diſtinct kinds of characters, which are in no wiſe dependent upon one another: their chemical properties

properties and their external qualities. The chemical properties, being considered as forming the nature of the body, constitute the foundation of them; but as these are not evident to the senses, external ones are used to denote them. This is very practicable with the species or individual objects, and is the very method nature points out to us; and is consonant to our usual manner of recognising them; but it becomes more and more difficult as we ascend to characterise the greater divisions, where we must form characters both to include and exclude a multiplicity of objects.

The same matter is found in a great variety of forms, and possessed of opposite external properties. If it were otherwise; if different species of a genus possessed invariably some external qualities common to all, though differing in others; if the different genera of an order likewise invariably possessed some

qualities common to all, though differing in others, there would be no difficulty of forming external generic characters, under which the species should be ranged; nor a difficulty of forming the characters of the orders under which the genera should be ranged. But when the same matter is found with different, and often opposite, external properties, it is impracticable. What system but a chemical one can bring together the well-characterised crystals of quartz with fine sand; calcareous spar with the scaly earth of Gera; and crystals of fluor with the impalpable powder of Mamoruch? Yet these bodies, apparently so different, are essentially the same; but the latter are without any of the external characters of the former; that is, without those signs the certain concomitancy of which should have indicated, had they been present, their essential properties.

The

The taſk then is truly difficult; and this is the beſt apology for the hitherto very imperfect ſyſtematic works, which have appeared with us, and on the continent, which are rather deſcriptive catalogues than ſyſtems. In none of theſe, except in the new edition of Linnæus by the learned Profeſſor Gmelin, are there thoſe ſpecific characters, and thoſe tables of the orders and genera which would ſo much aſſiſt us in inveſtigating mineral bodies, by leading us from the claſs, through the order, to the genus and ſpecies, and which are univerſally adopted by zoologiſts and botaniſts.

In regard to the diviſion of mineral bodies into claſſes, orders, genera, ſpecies and varieties, mineralogiſts are not agreed; but they are unanimous in conſidering the ſalts, earths, inflammables and metals, as ſo many ſeparate claſſes. The orders and genera are variouſly formed. With ſome each primi-

tive

tive earth and metal conſtitutes an order; with others the primitive earths form orders, but the metals only genera; whilſt with others, both the earths and the metals only conſtitute genera. The ſame want of method extends to the ſpecies. Thus in the improved edition of Linnæus, the characters which conſtitute the ſpecies in gypſum form genera in the carbonate of lime; for the pulverulent, fibrous, ſpathous, and compact kinds of gypſum form but ſo many ſpecies, whilſt the pulverulent, fibrous, ſpathous, and compact kinds of carbonate of lime form ſo many different genera. The primitive earths and metals ſhould conſtitute ſo many different orders, and the various derivative earths formed by their combination, as given in the fourth chapter, ſhould conſtitute the genera; then the different forms and other external properties would conſtitute the ſpecies and varieties.

rieties. Syſtematic arrangements muſt be uſed, however imperfect, or ſcience and our own ideas would be in the confuſion of chaos; and rejecting them becauſe they are imperfect, is rejecting a great advantage becauſe it might be greater.

One cauſe of the imperfection of our mineralogical ſyſtems, both with reſpect to the characteriſtic differences and claſſification, has been, that their authors rather were chemiſts than naturaliſts, and little acquainted with the Linnæan mode of arranging natural bodies.——Were the great Swediſh naturaliſt to return amongſt us, in the preſent ſtate of mineralogical knowledge, I do not doubt but he would render us that ſervice in the claſſification of theſe bodies, which he did in the other branches of natural hiſtory, by a judicious application of eaſy chemical teſts joined to their external characters. Till ſomething of this kind is done,

done, I muſt ſay, and lament that it is ſo, that our ſyſtems of minerals are little better than catalogues.

Notwithſtanding Mr. Werner's improvements, our deſcriptions are ſtill very imperfect. They are unneceſſarily long; and as there are never any ſhort or ſpecific characters prefixed either to the ſpecies or the genera, the inveſtigation of a mineral is extremely tedious. And further, though all the different characters which are ever found in a ſpecies are given, we ſtill remain ignorant of the concomitant characters; for ſome of theſe characters are invariably found together, and others are as invariably abſent: yet we know not by theſe deſcriptions which are concomitants, conſequently muſt have but an imperfect knowledge of the objects deſcribed. If, for example, we take the moſt common object of the mineral kingdom, Quartz, we find it deſcribed with

all the different colours of which it is found, as red, roſe, violet, &c. and with all the forms, as the regular cryſtalline, cellular, &c. &c. yet we know not whether there ever was ſuch a thing in nature as roſe-coloured cellular quartz, or violet-coloured cryſtals of quartz. This is certainly a ſhort method; but it does not anſwer the purpoſes of deſcription, and is no better in mineralogy, than it would be in botany to deſcribe the different ſpecies of a genus, by ſaying, that they are found with ovate, lanceolate, and reniform leaves; with ſingle flowers, and with flowers in ſpikes; with thorns, and without them; herbaceous, and fruteſcent; leaving botaniſts to divine what characters occur in the ſame ſpecies. We ſhould rather give a general character common to all of the genus or ſpecies, and then give the particular characters of the ſpecies or varieties.

Till we can agree on the principles on

which the characters of the genera and ſpecies ſhould be formed, it would be difficult to give a proper *formula* for deſcriptions; as what ſhould enter into the character of the ſpecies in one ſyſtem, would in another enter into that of the genus. The following may ſerve as ſpecimens of deſcriptions according to the Wernerian School. The firſt is a literal tranſlation from Mr. Werner's work on the external characters of foſſils; it is the deſcription of ſelenite.

SELENITE.

" Is of a pure white colour,
Amorphous,
Has an uneven ſurface,
Externally is ſcarcely glimmering,
Internally is ſplendent,
Upon the whole of a common luſtre,
Is compoſed of great even leaves,
Breaks into rhomboidal pieces,

Is pellucid,
Very soft,
In thin pieces, rather elastic,
Sounds a little,
Is dry (the feel),
Rather cold, yet less than talc,
Is not remarkably heavy."

Against this I have nothing particular to say, but that the same might be expressed with fewer words. The following description of flint by Mr. Wiedenman, a Wernerian mineralogist of the first rank, is tediously long, yet not selected on account of its length.

"FLINT has commonly a dark-smoke or yellow-grey colour, which on the one hand runs into the black, and on the other into the ochre-yellow and brown. Often several of these colours are formed in streaks or spots in the same specimen.

Flint is found in blunt-cornered, roundish, and

and tuberous (ſtuchen) forms; further, in foreign external forms, as in the forms of Echinites, Vermiculites, &c. It is found, likewiſe, though very ſeldom, like petroſilex in falſe cryſtals.

The ſurface of flint is partly rough, partly uneven, or ſurrounded with a coating of chalk; it is ſeldom ſmooth.

Externally it is either dull or glimmering; internally, on the contrary, conſtantly glimmering.

Its fracture is the perfect flat-conchoidal.

The fragments are indeterminate-cornered, and very ſharp-edged.

Commonly flint has no *compound texture*, yet ſometimes is in fortification and teſtaceous forms.

It is ſubdiaphanous at the edges, and paſſes often into the ſubdiaphanous the lighter the colour is.

It is hard in a higher degree than rock cryſtal.

Fragile,
Feels cold,
Is not particularly heavy."

Then its habitat and œconomical uſes are given.

Linnæus, I think, would rather have expreſſed the ſame in the following manner; in which the eſſential characters are firſt given, and the accidental ones thrown into a general deſcription.

FLINT.

Tecture compact.
Fracture ſmooth, flat-conchoidal.
Luſtre internal, glimmering.
Hard.
Fragile.
Subdiaphous at the edges, and ſubdiaphanous.
Fragments very ſharp-edged.

It is found in polymorphous nodules, and

ſometimes in ſmall beds, and in the extraneous forms of the echinæ, &c. in the chalk rocks inveſted with a chalky cruſt, and ſometimes, though very ſeldom, in falſe cryſtals. The *colour* varies from the ſmoke-colour to the black, and from the ſmoke to yellow ochre and brown; and ſometimes theſe occur together in ſtreaks and ſpots.

Mr. Eſtner's deſcription of the ſame foſſil begins by comparing it to horn: this takes ſix lines. Then the colour is given in twelve lines, the ſhape in fifteen, and the deſcription of its ſurface in ſix. In ſhort, the whole deſcription takes up above two octavo pages.——Mr. Emmerlings is equally prolix. The firſt fourteen lines are entirely upon the colour. In moſt of the deſcriptions of theſe eminent mineralogiſts, in inveſtigating a foſſil, we have a page to read through before we come to the eſſential characters. I wiſh to ſee the Wernerian ter-

minology employed in the Linnæan method; beginning the deſcription by thoſe qualities which are moſt characteriſtic, and throwing ſuch as ſhould only form the varieties into a general deſcription; though in many caſes it will be better to enumerate the varieties, and diſtinguiſh them by ſhort characters; for nothing tends ſo much to give us clear notions of things, as applying diſtinct names and diſtinguiſhing characters to different objects.

On the mode of inveſtigating an unknown mineral I know not what to adviſe, as our ſyſtems are compoſed. From what I have already ſaid in this chapter, it will appear, that firſt the claſs, then the order, and then the genus and ſpecies to which it belongs, are to be aſcertained; and conſequently thoſe characters are to be ſought for in the object of enquiry which form the characters of the claſs, order, &c. If

chemical, chemical tests must be employed to detect them; if external characters are used, they are readily found, as they are given in the ninth chapter.

CHAPTER XI.

On collecting of Specimens, forming of Cabinets, &c.

IN the apparently moſt ſimple things much is to be learnt by practice. It is not therefore quite unneceſſary to make ſome remarks on the manual and practical addreſs that may be uſeful to a mineralogiſt, ſuch as breaking off ſpecimens, packing them, and the forming of cabinets.—Cryſtals, and many other mineral productions, never come under the ſtroke of the hammer; but with the rupeſtrious foſſils it is otherwiſe. Theſe muſt either be detached from the rock, or, if found in looſe fragments, muſt have freſh ſurfaces given them. A large hammer not leſs than two pounds in weight, having one end with a thick edge, ought always to be

ufed, fo that the fpecimens may be detached or new furfaces given at one ftroke; for it is of much importance that the ftroke of the hammer fhould not appear in the fpecimens, which in general it will be, if the effect is produced by repeated blows. A fmall hammer will occafionally be ufeful. The frefh fracture fhould always be kept perfectly clean, and never, if it can be avoided, touched with the fingers, as the principal characters, the texture and fracture, are only feen here. The fpecimens in general fhould be about two or three inches in each direction; in the homogeneous foffils they may be fmaller, but never in the coarfely compound rocks, as the pudding-ftones, breccia, &c. They fhould not be reduced into regular forms, as thofe into which they naturally break are fometimes characteriftic.

Specimens, fhould they be carried only a fmall diftance, ought to be firft carefully

wrapt

wrapt in ſtrong paper; and if they are to be ſent far, they muſt then be packed cloſe in a ſtrong box or cheſt, with a little hay between each layer of ſtones: they cannot well be packed too tight. Delicate cryſtallizations, and ſuch foſſils as are very fragile, ſhould be packed with cotton or tow in light chip boxes, before they are put amongſt the others. With theſe precautions I have tranſported with me foſſils from the moſt remote parts of Hungary, without their having received the ſmalleſt injury.

In regard to arranging foſſils in a cabinet, nothing but general rules can be given, as collections ſo greatly vary in their extent. For an handſome, yet ſcientific collection, I would recommend a cabinet with drawers about three inches deep, and above the drawers a glaſs-caſe, like a book-caſe, for the more ſplendid, coſtly and larger ſpecimens. The ſhelves may be ſloping forwards,

wards, that more ſpecimens may be exposed to view, with narrow ribs to prevent them from ſlipping.

The ſpecimens ſhould be numbered, and a catalogue formed, in which the ſcientific name of each ſpecimen ſhould be written, and the habitat, if known, never omitted.

Thoſe who enter into the ſtudy of mineralogy with ſpirit will immediately be deſirous of poſſeſſing a ſmall chemical laboratory. Of this I need ſay nothing, as in books of chemiſtry the requiſite information may be found. I earneſtly recommend the uſe of the blow-pipe, as often by a ſingle blaſt the eſſential nature of a foſſil is detected, when all the exterior characters have been ſilent.

The nitrous or muriatic acid will be found ſometimes extremely uſeful; and a good ſimple lens and a knife muſt always be in the pocket of a mineralogiſt. With the latter,

ter, after a little practice, he will be able readily to find the hardneſs of moſt foſſils; and the former will furniſh him with very accurate knowledge of their texture, and be of particular uſe in many of his geological ſpeculations on their formation.

CHAP-

CHAPTER XII.

Catalogue of Works in Mineralogy.

WHOEVER makes mineralogy his particular ſtudy, muſt wiſh to have a liſt of the beſt works in its different branches. To the writer it is almoſt indiſpenſable. It is always requiſite for him to know what others have thought and written upon thoſe ſubjects which are to be elucidated by his labours; or he may give to the world as new, opinions which have formerly been current, but long ſince laid aſide, and become obſolete through later diſcoveries. I therefore ſubjoin the following Catalogue

Of its Hiſtory and Literature.

L. F. Gronovii Bibliotheca regni animalis atque lapidei. Lugd. Bat. 1760. 4to.

J. G. Wallerii Brevis introductio in hiſtoriam literariam

riam mineralogicam, atque methodum ſyſtemata mineralogica rite condendi. Holmiæ, Upſaliæ et Aboæ, 1779. 8vo.

D. G. R. Boehmeri Bibliotheca ſcriptorum hiſtoriæ naturalis, œconomiæ aliarumque artium, ac ſcientiarum ad illam pertinentium, realis ſyſtematica. P. IV. Mineralogi. Vol. I. Lipſ. 1788. Vol. II. 1789. P. V. Hydrologi. 1789. 8vo.

J. F. Gmelin's C. von Linné natur ſyſtem des mineral reichs. 1ſt P. S. 83 to 306.

Les anciens mineralogiſtes du royaume de France, avec des notes par Mr. Gobet. P. I. II. à Paris, 1779.

D. L. Crells Chemiſcher journal. Lemgo, 1778. 8vo. 1—6 theil.

Ditto Neueſte entdeckungen in der chimie, Leipz. 1781. 1—12 theil. 8vo.——Auſwahl aller eigen thumlichen abhandlungen aus denſelben. Leipz. 1786. 1—4. Vol. 8.

Ditto Chemiſhe annalen. Helmſt. & Leipz. 1784—89. 8—12 vol. & Beiträge zu den chem. annalen. Helmſt. et Leipz. 1786. 1 & 2 vol. 8vo.

D. S. F. Hermbſtädt Bibliothek der neueſten phyſich-chemiſchen metallurgiſchen technologiſchen et pharmaceutiſchen literature. Berlin, 1786. 8vo.

J. Beck-

J. Beckmann's Physikalisch-œconomishe bibliothek. Göttingen, 1770.

Bibliothek der gesammten naturgeschichte. J. Fibig & B. Nau, Frankf. & Mainz. 1789. 8vo.

J. S. Schröter's Journal für die liebhaber des steinreichs et der conchyologie. Weimar, 1774. 8vo.

J. F. Lempe Magazin für die bergbaukunde. Dresden, 1785. 8vo. 1—3 th.

Bergmännisches Journal. Freiberg, 1788. 8. by A. W. Köhler.

Anleitung zur kenntniss der besten bücher in der mineralogie, &c. by C. F. W. Schall. 2d edit. 1789. 8vo.

Systems.

Car. a Linné Systema naturæ. T. III. Edit. xiii. Vindob. 1767. 8vo.

——— ditto, cura Gmelin. Lipsiæ, 1793.

Ditto. Volfständige's Natursystem des mineralreichs nach der 12ten Ausgabe in einer freien et vermerhrten Uebersetzung von J. F. Gmelin. Nürnb. 1777. 1—4. Theil. 8.

Mineralogia, ellen mineral riket indelt och beskrifwit af J. G. Wallerius. Stockholm, 1747. 8vo. et aus

dem

dem schwed. übersezt, von J. D. Denso. Berlin, 1750. 8vo.

J. G. Wallerius Systema mineralogicum. Ed. 2d. Holm. 1772. T. I. II. Vindob. 1778. T. I. II. 8vo. Ubersezt von N. G. Leske et Hebenstreit. Berlin, 1781. 1 & 2 B. 8vo.

Henckllus in mineralogia redivivus. Dresd. 1759. 8vo.

The History of fossils, by John Hill. 1748. Fol. Lond.

Fossils arranged according to their obvious characters, &c. by J. Hill. Lond. 1771, in 8vo.

A Natural history of fossils, by Em. M. da Costa, 1757.

An Introduction to mineralogy, by J. R. Forster, 1768.

The Mirror of stones, by Camillus Leonardus. London, 1750.

J. L. Woltersdorf Syst. minerale, &c. Berlin, 1748 & 1755. 4to.

F. A. Cartheuser Elem. mineralogiæ, &c. Franckf. ad Viadr. 1755. 8vo.

L'Histoire naturelle éclaircie dans la lithologie & la conchyliologie, par Mr. —— (Desalier d'Argenville) à Paris, 1742. 4to.

L'Histoire naturelle eclaircie dans l'Oryctographie, par Mr. —— (D. D'Argenville), à Paris, 1755.—4.

J. H. G. von Justi Grundriss des gesammten mineralreichs. Götting. 1757. 8vo.

(Axell

(Axel von Cronſtedt) Förſök til mineralogie, eller mineralrikets upſtoalning. Stockh. 1758. 8vo.

Verſuch einer neuen mineralogie. Aus dem Sehwediſchen übers. Kopenh. 1760 8—vermehrt durch Brünnich. Kopenh. & Leipzig, 1770. 8vo.

Eſſay towards a ſyſtem of mineralogy by Cronſtedt, reviſed and corrected by Em. Mendez da Coſta. Lond. 1770. 8vo.

———— enlarged and improved by M. Magellan. Lond. 1788. 2 vol. 8vo.

Eſſai d'une nouvelle mineralogie traduit du Suedois et de l'Allemand de Mr. Wedmann, par Mr. Dreux, à Paris, 1771. 8vo.

Verſuch einer mineralogie, aufs neue aus dem Schwediſchen überſezt, &c. von A. G. Werner, Leipz. 1780. 8vo. (Of which only the firſt part has yet appeared).

J. G. Lehmann's Kurzer entwurf einer mineralogie. Berl. 1758. 8vo. 2te. Aufl. Berl. 1760. 3te Aufl. Nürenb. 1769. 8vo.

Introduction à l'étude des corps naturels, tirés du regne mineral, par Mr. Bucquet, à Paris, 1771.

Nouveau ſyſteme de mineralogie, par Mr. Monnet, 1779. 8vo.

R. A. Vogels Practiſches mineral ſyſtem. Leipzig, 1762 and 177 . 8vo.

Mineralogie, ou nouvelle exposition du regne mineral, par Mr. Valmont de Bomare, à Paris, 1762, T. I. II. 8vo. Aus dem Franz. übers. Dresd. 1769. 8vo, 1 & 2 Th.

J. W. Baumer Naturgeschichte des mineral reichs mit besonderer Anwendung auf Thüringen. Gotha, 1763—64. 1 & 2 Band.

J. A. Scopoli einleitung zur Kenntniss & Gebrauch der fossilien. Riga et Mitau, 1769. 8vo.

Ejusd. principia mineralogiæ systematicæ et practicæ Pragæ.

Dessen anfangsgründe der systematischen & practischen mineralogie, aus dem Latein. übers. von D. Müdinger. Prag. 1775. 8vo.

Ejusd. Introductio ad historiam naturalem. Pragæ, 1777. 8vo.

Elements of fossiliology by G. Edwards. Lond. 1776. 8vo.

Peithner's Erste Gründe der bergwerks wissenschaft. Prag. 1770. 8vo.

C. A. Gerhardt's Beiträge zur chymie et geschichte des mineral reichs. Berlin, 1773—76. 1—2 Th. 8vo.

———— Versuch einer geschichte des mineral reichs. Berlin, 1781—82. 1 & 2 Th. 8vo.

———— Grundriss des mineral systems zu vorlesungen. Berlin, 1786. 8vo.

J. F.

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FINIS.

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BENEVOLENCE, considered as a Source of HAPPINESS.

TRACTS and OBSERVATIONS in NATURAL HISTORY and PHYSIOLOGY.

Explanation of Plate I.

IT repreſents the Undulating Strata of Stratified Hills by an example in the diſtrict of Manſfield in Germany.

a is the Soil.

b a Stratum of Clay—about 2 to 3 fathoms.

c ——— of Sand mixed with Clay—about 2 fathoms.

d ——— of Bituminous Limeſtone, or Lapis Suillus—4 to 6 fathoms.

e ——— of Sandy Limeſtone (Sandige Kalkerde)—1 to 2 fathoms.

f ——— of Porous Limeſtone (Löchriger Kalkſtein)—from half a yard to 6 or 8 fathoms.

g ——— of Compact Limeſtone—2 to 6 fathoms.

h ——— of Marl-Shiftus (Mergel-Schiefer)—about a foot.

i ——— of White Sand Stone
k ——— of Red Sand Stone
} Of theſe and the following Mr. Gerhard gives no meaſurements.

l ——— of Coarſe Ferruginous Sand Stone.

m is a Depreſſion (Mulde).

n a Saddle.

Explanation of Plate II. which forms the Vignette.

IT repreſents ſeveral Veins and one Bed of Ore in a Primitive Rock.

1 the diviſions of the different beds.

2 a *Bed* of Ore; of which *a* and *b* are the *Side-Rocks*: *a* is the *Roof*, and *b* the *Floor*.

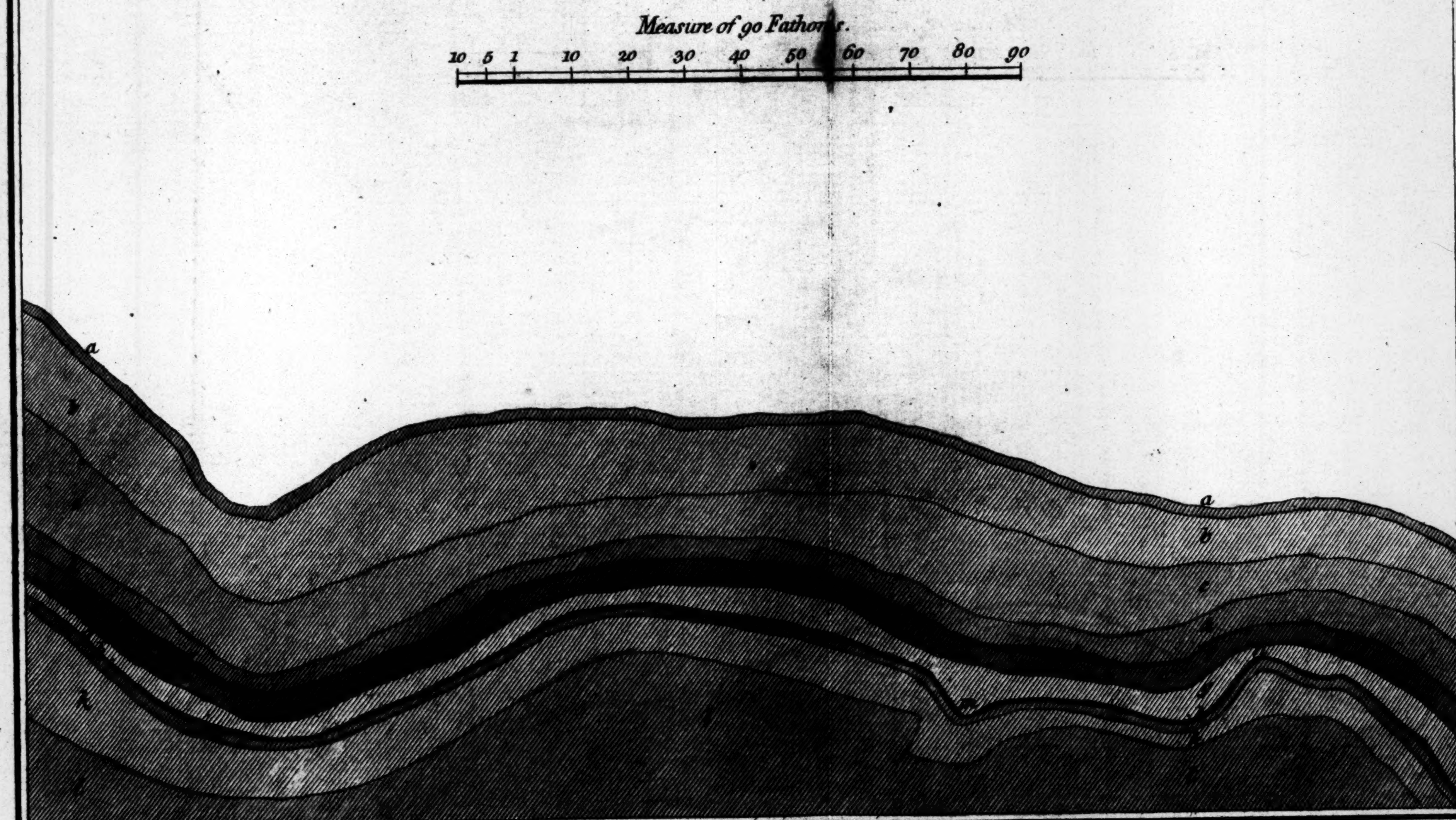
3 are the Veins, of which *c* and *d* are the *Side-Rocks*: *c* is the *Roof*, and *d* the *Floor*.

4 repreſents a *Fault*, where, through a change in the ſituation of the Beds, the Vein is broken and diſplaced.

Explanation of Plate III.

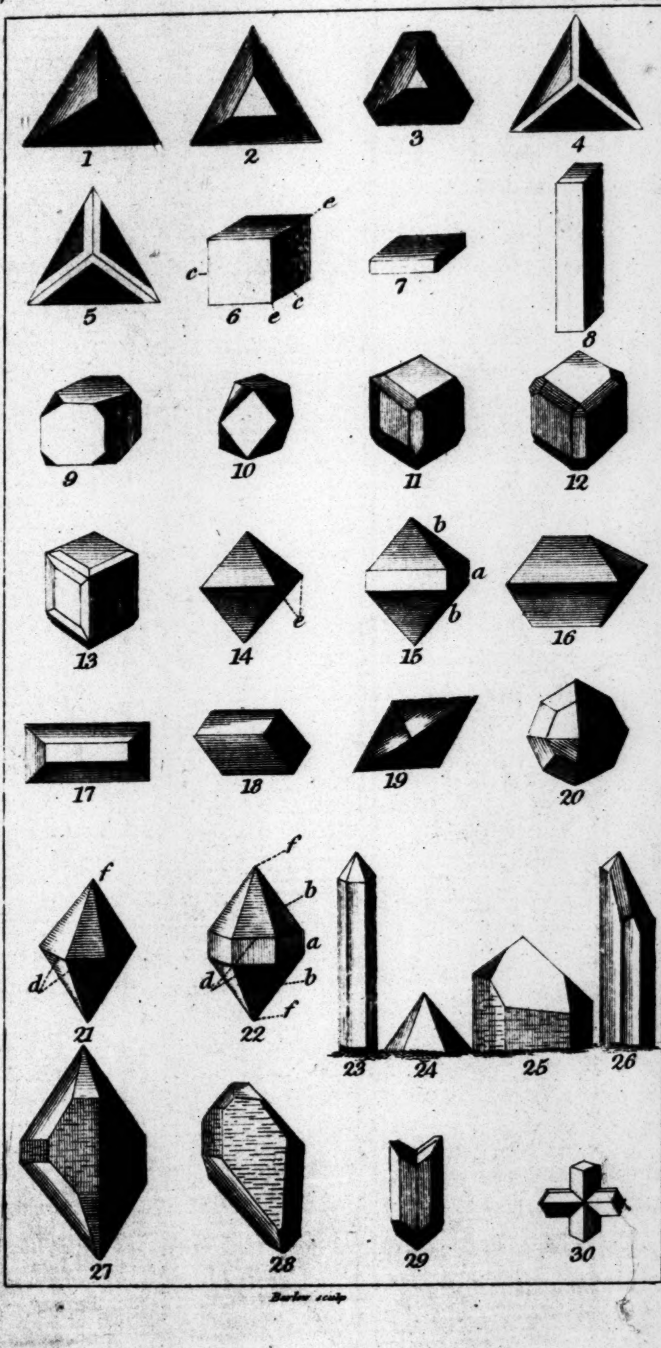
Fig. 1 The regular Tetraedron.
2 ———— with the Summit truncated.
3 ———— with all the four Corners truncated.
4 ———— with the Edges truncated.
5 ———— with the Edges bevelled off.
6 The Cube. *c* repreſents the Edges; *e* the Corners.
7 The regular Square Table.
8 A rectang. quadrangular Priſm.
9 The Cube with the Corners truncated.
10 The ſame deeper truncated.
11 The Cube with the Edges truncated.
12 The Cube with both the Edges and Corners truncated.
13 The Cube with the Edges bevelled off.
14 The Octaedron—*e* the Corners.
15 The ſame with a Priſm—*a* the Priſm—*b* the Pyramids.
16 The elongated Octaedron.
17 The ſame with the ſummits of the Pyramids truncated.
18 The Rhomb.
19 The Rhomboidal Octaedron.
20 The 24edron.
21 The Dodecaedron with triangular ſides—*d* the Angles of Incidence—*f* the Summits.
22 The ſame with a Priſm—*a* the Priſm—*b* the Pyramids—*d* the Angles of Incidence—*f* the Summits.
23 The ſame with only one Pyramid and the Priſm elongated.
24 The ſame with only one Pyramid.
25 The ſame as 23, but very irregular, and with a ſhorter Priſm.
26 The ſame as 23, but very irregular.
27 The ſame as 22, but very irregular.
28 The ſame as the preceding, but more irregular.
29 A Macle by the junction of the ſimilar Sides of two Cryſtals.
30 A Macle by two Cryſtals croſſing each other.

Pl. I.



Barlow sculp.

A Sketch of the Stratified Hills in the District of Mansfield in Germany.



Barlow sculp